

MicroVent Ventilator

Operating Instructions
Software 1.n



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Introduction

Operator's Responsibility for Patient Safety

For correct and effective use of the product and in order to avoid hazards it is mandatory to carefully read and to observe all portions of this manual.

The design of the equipment, the accompanying literature, and the labeling on the equipment take into consideration that the purchase and use of the equipment are restricted to trained professionals, and that certain inherent characteristics of the equipment are known to the trained operator. Instructions, warnings, and caution statements are limited, therefore, largely to the specifics of the Dräger design. This publication excludes references to various hazards which are obvious to a medical professional and operator of this equipment, to the consequences of product misuse, and to potentially adverse effects in patients with abnormal conditions.

Product modification or misuse can be dangerous. Dräger, Inc. disclaims all liability for the consequences of product alterations or modifications, as well as for the consequences which might result from the combination of this product with other products whether supplied by Dräger or by other manufacturers if such a combination is not endorsed by Dräger, Inc..

The operators of the ventilator system must recognize their responsibility for choosing appropriate safety monitoring that supplies adequate information on equipment performance and patient condition. Patient safety may be achieved through a wide variety of different means ranging from electronic surveillance of equipment performance and patient condition to simple, direct observation of clinical signs. The responsibility for the selection of the best level of patient monitoring lies solely with the equipment operator. (See also page 12, "Medical Attention").

Limitation of Liability

Dräger, Inc.'s liability, whether arising out of or related to manufacture and sale of the goods, their installation, demonstration, sales representation, use, performance, or otherwise, including any liability based upon Dräger, Inc.'s Product Warranty, is subject to and limited to the exclusive terms and conditions as set forth, whether based upon breach of warranty or any other cause of action whatsoever, regardless of any fault attributable to Dräger, Inc. and regardless of the form of action (including, without limitation, breach of warranty, negligence, strict liability, or otherwise).

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Dräger, Inc. shall not be liable for, nor shall buyer be entitled to recover any special incidental, or consequential damages or for any liability incurred by buyer to any third party in any way arising out of or relating to the goods.

Warranty

All Dräger products are guaranteed to be free of defects for a period of one year from date of delivery. The following are exceptions to this warranty:

1. The defect shall be a result of workmanship or material. Defects caused by misuse, mishandling, tampering, or by modifications not authorized by Dräger, Inc. or its representatives are not covered.
2. Rubber and plastic components and materials are warranted to be free of defects at time of delivery.
3. Oxygen sensors capsules have a six-month limited warranty from the date of delivery.

Any product which proves to be defective in workmanship or material will be replaced, credited, or repaired with Dräger, Inc. holding the option. Dräger, Inc. is not responsible for deterioration, wear, or abuse. In any case, Dräger, Inc. will not be liable beyond the original selling price.

Application of this warranty is subject to the following conditions:

1. Dräger, Inc. or its authorized representative must be promptly notified, in writing, upon detection of the defective material or equipment.
2. Defective material or equipment must be returned, shipping prepaid, to Dräger or its authorized representative.
3. Examination by Dräger, Inc. or its authorized representative must confirm that the defect is covered by the terms of this warranty.
4. Notification in writing, of defective material or equipment must be received by Dräger, Inc. or its authorized representative no later than two (2) weeks following expiration of this warranty.

In order to assure complete protection under this warranty, the Customer Registration Card and/or Periodic Manufacturer's Service Record (if applicable) must be returned to Dräger within ten (10) days of receipt of the equipment.

The above is the sole warranty provided by Dräger, Inc. No other warranty expressed or implied is intended. Representatives of Dräger are not authorized to modify the terms of this warranty.

Dräger, Inc., Telford, PA

Definitions

WARNING !

A **WARNING** statement refers to conditions with a possibility of personal injury if disregarded.

CAUTION !

A **CAUTION** statement designates the possibility of damage to equipment if disregarded.

NOTE: A **NOTE** provides additional information intended to avoid inconveniences during operation.

Inspection = examination of actual condition

Service = measures to maintain specified condition

Repair = measures to restore specified condition

Maintenance = inspection, service, and repair, where necessary

Preventive Maintenance = Maintenance measures at regular intervals

Typing conventions in this manual

Controls are designated as »Control Name« , e.g:
»PEEP«

Screen messages are printed in a window, e.g:

Self test O.K.

General WARNINGS and CAUTIONS

WARNING !

Strictly follow this Operator's Instruction Manual

Any use of the product requires full understanding and strict observation of all portions of these instructions. The equipment is only to be used for the purpose specified under "Intended Use" (see page 12) and in conjunction with appropriate airway monitoring (see page 6). Observe all **WARNINGS** and **CAUTIONS** as rendered throughout this manual and on labels on the equipment.

WARNING !

DANGER, risk of explosion if used in the presence of flammable anesthetics.

This device is neither approved nor certified for use in areas where combustible or explosive gas mixtures with air or with nitrous oxide are likely.

WARNING !

Whenever a patient is connected to the ventilator, constant attention by qualified medical staff is required in order to provide immediate corrective action in case of a malfunction.

The operator shall not rely on the built-in monitoring of the ventilator and must always assume full responsibility for proper ventilation and patient safety in all situations.

WARNING !

If a fault is detected in the ventilator and its life-support functions are in doubt, ventilation must be started without delay with an independent ventilation device (resuscitation bag) - using PEEP and/or increased inspiratory O₂ concentration where necessary and appropriate. The unit should then be removed from use and serviced by an authorized service technician.

Precautions During Preparation

CAUTION !
Restriction of Distribution

Federal Law and Regulations in the United States and Canada restrict this device to sale by or on the order of a physician.

CAUTION !
Traceability

Federal Law in the United States requires traceability of this equipment. Please return the self addressed registration card included with the product and fill in the required information.

CAUTION !
Maintenance

In case of malfunction of this device, contact your local DrägerService or our Factory Authorized Technical Service Center.

The device must be inspected and serviced (preventive maintenance) by competent and factory authorized technical service representatives at regular 6 month intervals. A record must be kept on this preventive maintenance. We recommend obtaining a service contract through your vendor.

Maintenance or repair of the MicroVent shall be performed only by Dräger authorized technical service representatives.

Precautions During Preparation

WARNING !

Always verify that valve membrane is installed in correct orientation. Ventilator malfunction will occur if silicone membrane is reversed.

WARNING !

Always use an independent oxygen analyzer to monitor inspiratory oxygen concentrations.

WARNING !

Do not use antistatic (electrically conductive) patient circuits or tubing.

WARNING !

Treatment of batteries:

Do not throw into fire! Do not force open!
Do not attempt to recharge alkaline batteries!
Danger of bodily injury.

Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries.

WARNING !

- Always use extreme caution when using oxygen!
- Oxygen intensely supports any burning!
No smoking, no open fire in areas where oxygen is in use!
- Always provide adequate ventilation in order to maintain ambient O₂ concentrations < 24 %
- Always secure O₂ cylinders against tipping, do not expose to extreme heat.
- Do not use oil or grease on O₂ equipment such as tank valves or pressure regulators. Do not touch with oily hands. Risk of fire!
- Open and close valves slowly, with smooth turns. Do not use any tools.

WARNING !

Do not install flow restricting valves or flow meters into the high pressure gas supply. Equipment malfunction might result.

WARNING !

Always use medical grade oxygen and air that is dry and free from dust and oil. Contaminated gas may cause ventilator malfunction.

CAUTION !

Always use elbow connector for accurate flow measurement.

CAUTION !

Always use AC adapter 84 12 709 for connecting device to 120 V AC line voltage.

CAUTION !

Always use DC/DC converter 84 13 017 when charging from a DC source.

CAUTION !

Do not pressurize the connector for pressure sensing lines. It might destroy the internal sensor.

CAUTION !

For safety reasons, a battery pack must always be installed, even when using external power supplies!

WARNING !

Automatic patient ventilation, volume measurement, and alarms are not functional in case of a loss of electric power!
Spontaneous breathing through the integrated demand valve, however, is still possible in that situation,

Immediately start ventilating patient with independent manual ventilation device (resuscitation bag) using PEEP and/or increased inspiratory oxygen concentration where necessary and appropriate.

WARNING !

Continuous or intermittent audible alarms require immediate operator attention to avert or to prevent development of situations with the possibility of patient injury.

WARNING !

Do not block air intake. Ventilator malfunction will result.

WARNING !

Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

WARNING !

Observe pressure gauge in order to identify improper ventilation. Operator must always be ready to intervene if alarm indicates a situation dangerous to the patient.

WARNING !

Use CPAP mode only for patients who have sufficient spontaneous breathing.

WARNING !

Water remaining in the ventilator valve or in the pressure sensing lines for flow measurement may cause ventilator malfunction.

Precautions During Operation

Precautions During Care

Precautions During Maintenance

Precautions During Care (cont'd)

CAUTION !

When removing patient circuits, always handle at end fittings! Otherwise, support helix may be torn at end fitting or hose and fitting could come apart.

CAUTION !

Prevent any foreign objects from getting into the flow sensor.
Do not use pressurized air for cleaning, the orifice membrane inside the flow sensor may become damaged.

CAUTION !

Prevent any foreign objects from getting into the ventilator valve.
Be careful not to damage the silicone membrane or other disassembled parts.

CAUTION !

Do not use hard brush for cleaning.
Prevent any foreign objects from getting into the patient valve.

CAUTION !

Certain components of the ventilator consist of materials that are sensitive to certain organic solvents sometimes used for cleaning and disinfecting (e.g., phenols, halogen releasing compounds, oxygen releasing compounds, strong organic acids, etc.). Exposure to such substances may cause damage that is not always immediately recognized. Sterilization of the ventilator itself with ethylene oxide (EtO) is also not recommended.

CAUTION !

Follow all accepted hospital procedures for disinfecting parts contaminated by body fluids (protective clothing, eyewear, etc.).

Precautions During Maintenance

WARNING !

To avoid any risk of infection, clean and disinfect ventilator and accessories before any maintenance according to established hospital procedures - this applies also when returning ventilators or parts for repair.

WARNING !

Preventive Maintenance work on the MicroVent ventilator may be performed by trained and factory authorized staff only.

WARNING !

Never operate the ventilator if it has suffered physical damage or does not seem to operate properly. In this case always refer servicing to properly trained and factory authorized service personnel.

WARNING !

If, in case of damage to the ventilator, the glass of the LCD screen is broken, a liquid chemical may be released that should not come into contact with the skin. In case of contamination, wash off with soap immediately.

Intended Use

MicroVent – time-cycled, volume-constant ventilator for patients with a body weight of at least 15 kg (33 lbs) up to 150 kg (330 lbs).

Ventilation modes:

- controlled ventilation, CMV
- synchronised, controlled ventilation, Assist Control
- synchronised, intermittent mandatory ventilation, SIMV
- spontaneous breathing with positive airway pressure, CPAP - with optional pressure- supported PS during spontaneous breathing

With monitoring of:

- airway pressure, Paw
- expiratory minute volume, MV
- electrical power supply
- gas supply

The monitoring of inspiratory O₂ partial pressure must be safeguarded with an independent O₂ monitor.

Areas of use:

- intensive care wards
- recovery rooms
- patient transports

Medical Attention

WARNING !

Whenever a patient is connected to the ventilator, constant attention by qualified medical staff is required in order to provide immediate corrective action in case of a malfunction.

The operator shall not rely on the built- in monitoring of the ventilator and must always assume full responsibility for proper ventilation and patient safety in all situations.

Ventilation With an Independent Manual Ventilation Device

WARNING !



If a fault is detected in the ventilator and its life-support functions are in doubt, ventilation must be started without delay with an independent ventilation device (resuscitation bag) - using PEEP and/or increased inspiratory O₂ concentration where necessary and appropriate. The unit should then be removed from use and serviced by an authorized service technician.



Overview



Front Panel

- ① The knobs in the center of the front panel set:
 - **ventilator rate** f
 - **tidal volume** V_T
 - **inspiratory time** $T_{insp.}$
- ② Below, grouped together in one field, are the knobs for:
 - **max. airway pressure** P_{max} $\uparrow\downarrow$
 - **minute volume alarm limits, MV** $\uparrow\downarrow$
- ③ Next to this field, the knob for setting
 - **pressure support** during spontaneous breathing
 - **endexpiratory pressure, PEEP** and positive airway pressure, **CPAP**
- ④ Next to it, the switch for **ventilation modes**
 - **CMV / A/C** or **SIMV / CPAP**
- ⑤ **On/off switch, ON/OFF**
- ⑥ **Pressure gauge** for continuous display of airway pressure
- ⑦ **Liquid crystal display** for
 - **measured parameter values** (MV, PEEP, Peak, Mean, I:E, Insp. flow)
 - **Alarms and advisory messages** with  key to switch on display backlighting and to display measured parameter values.
- ⑧  **key** to temporarily silence audible alarms and to reset alarm messages after correcting the cause of an alarm.

Preparation

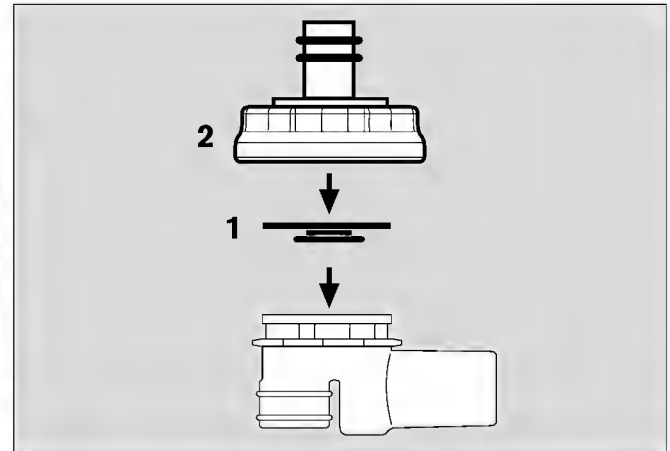
Installing the Patient Valve

- 1 Insert silicone membrane into open patient valve - watch for correct orientation of membrane

WARNING !

Always verify that valve membrane is installed in correct orientation. Ventilator malfunction will occur if silicone membrane is reversed.

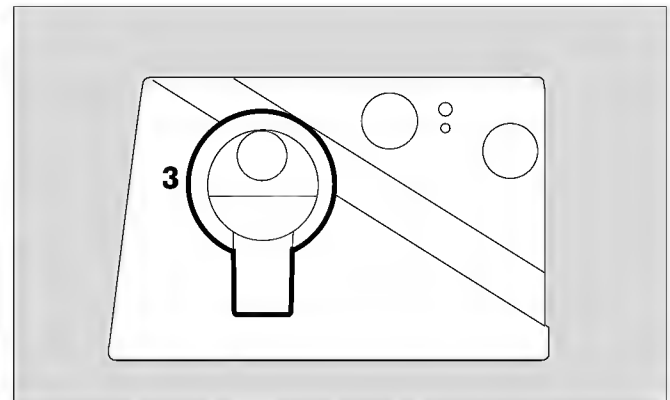
Take care not to damage or bend rubber disc inside patient valve. Ventilator malfunction will occur.



- 2 Put on lid and turn clockwise 90° to lock.
- 3 Push expiratory valve into the opening on the ventilator = nozzle pointing downwards.
- 4 Screw or push O₂ sensor firmly into the O₂ sensor adapter.
- 5 Attach O₂ sensor adapter to nozzle.

WARNING !

Always use an independent oxygen analyzer to monitor inspiratory oxygen concentrations.

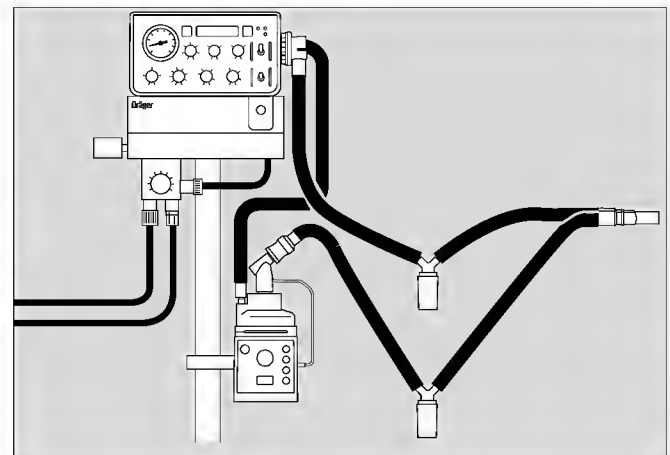


- Connect ventilator circuit to nozzles. Note suggested length of circuit segments (in meters).

WARNING !

Do not use antistatic (electrically conductive) patient circuits or tubing.

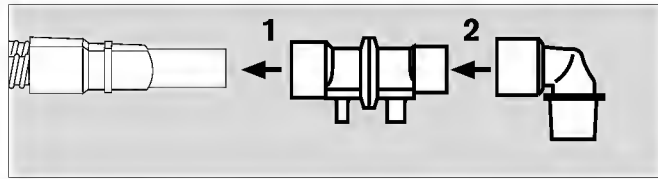
- Make sure watertraps are positioned vertically.
- Prepare humidifier according to its Operating Instructions.



- 1 Attach flow sensor to wye.
- 2 Push elbow connector onto flow sensor.

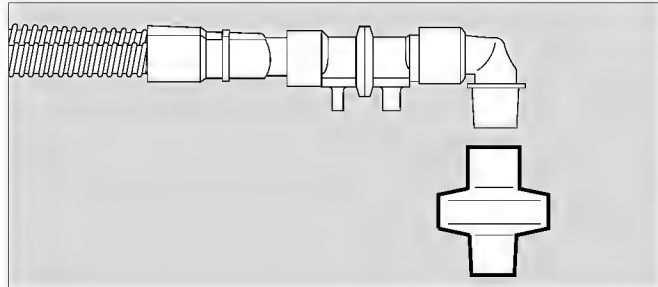
CAUTION !

Always use elbow connector for accurate flow measurement

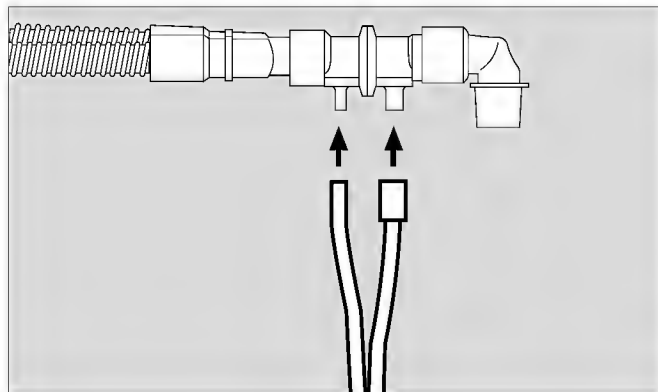


When using a bacterial filter

- Always connect bacterial filter to elbow connector as shown.



- Push pressure sensing lines for flow measurement onto flow sensor nipples – note different diameters of hose ends and respective nipples.

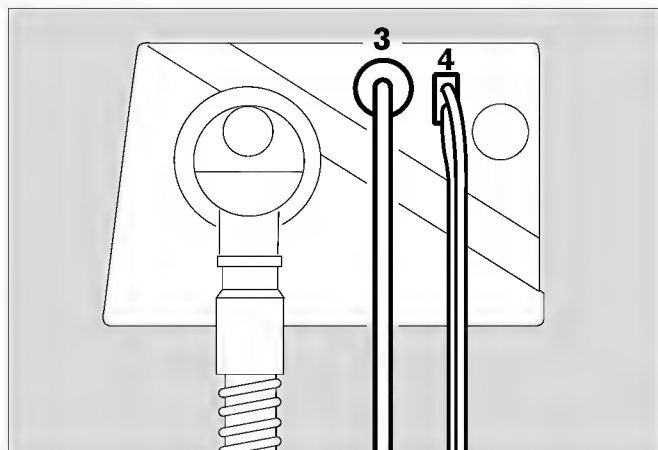


Pneumatic Connections

- 1 Attach gas supply line and tighten.
- 2 Attach pressure sensing lines for flow measurement to connector on MicroVent.

CAUTION !

Do not pressurize this connector for pressure sensing lines. It might destroy the internal sensor.



Electrical Supply

The MicroVent ventilator is designed for different types of electrical supply.

Internal supply

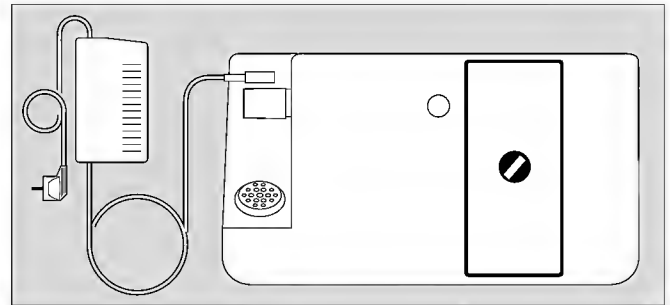
with either rechargeable (NiCd) or non-rechargeable (alkaline) internal battery pack.

CAUTION !

The internal battery pack will last for up to 2 hours of operation. Keep additional, fully charged battery packs on hand for backup if external sources might not be available for more than 2 hours.

CAUTION !

When exchanging the internal battery pack during operation, always assure that ventilation can be provided with an independent ventilation device (resuscitation bag) while the MicroVent is disconnected from power.



External supply

with AC adapter (part no. 84 12 709) from 120 V AC line voltage for recharging of battery pack and for extending operation when using battery packs.

CAUTION !

Always use AC adapter 84 12 709 for connecting device to 120 V AC line voltage.

CAUTION !

For safety reasons, a battery pack must always be installed, even when using external power supply!

Use with internal rechargeable battery pack or alkaline batteries

Installation

- before first use
- when, during charging NiCds, the display shows

Defective NiCd

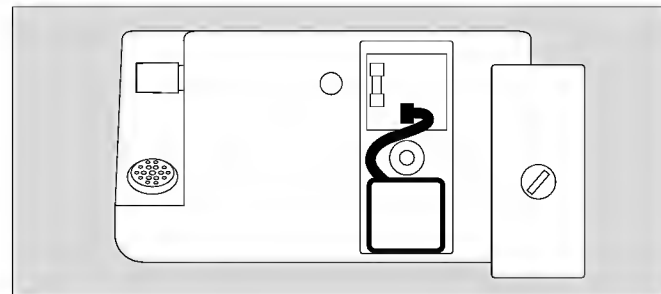
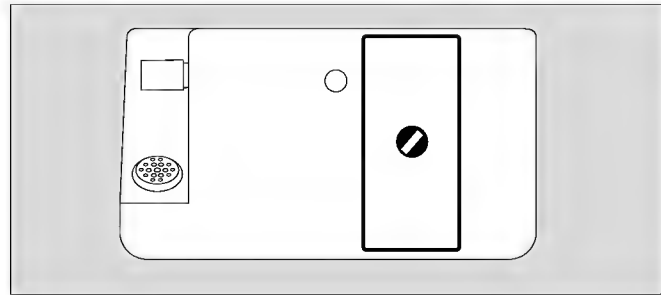
- and as part of preventive maintenance every 2 years.

CAUTION !

Always use alkaline batteries, type IEC LR6 (AA batteries).

NOTE: Always use battery holder, part no. 18 35 505, in battery compartment

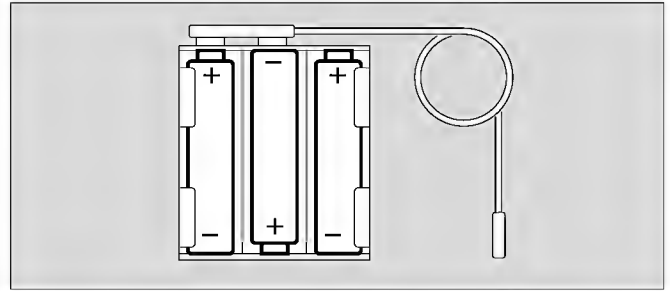
- Undo screw in lid of battery compartment (use coin) and remove lid.



- Remove and disconnect defective or discharged battery pack.
- Remove used alkaline batteries from battery holder and replace with 6 new batteries (where applicable).

NOTE: Watch for correct polarity when inserting new batteries.

- Attach plug of fresh battery pack to receptacle in battery compartment and insert pack.
- Install lid and tighten screw



WARNING !

Treatment of batteries:

Do not throw into fire! Do not force open!
Do not attempt to recharge alkaline batteries!
Danger of bodily injury.

Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries.

The ventilator can be operated for about 2 hours with a fresh set of batteries.

For advisory or alarm messages, see table "Troubleshooting" on pages 50-52.

Charging NiCd batteries


NOTE: NiCd batteries will slowly discharge even while connected to an external power supply. It takes about 2 years for batteries to discharge completely under those circumstances

NOTE: Always charge at ambient temperatures of 32 °F to 95 °F (0 °C to 35 °C)!

CAUTION !

Always use AC adapter 84 12 709 for connecting device to 120 V AC line voltage.

When external voltage is connected:

- the green status light  = "DC power available" will be on, independent of whether the ventilator is turned »On« or »Off«. The internal battery pack is now being charged.
- Display while ventilator is turned off:

**Stand-by
NiCd charging**

- It takes about 5 hours to recharge a completely discharged NiCd battery pack.
- Display while ventilator is turned off:

**Stand-by
NiCd charged**

At room temperature, the ventilator can be operated for about 2 hours with a fully charged NiCad battery pack.

- Near the end of battery capacity, the ventilator displays

Charge NiCd

Approximately 10 minutes of operation remain at the time of this message.

NOTE: Low ambient temperatures and the actual condition of the rechargeable batteries may reduce operating times.

Use with external DC supply

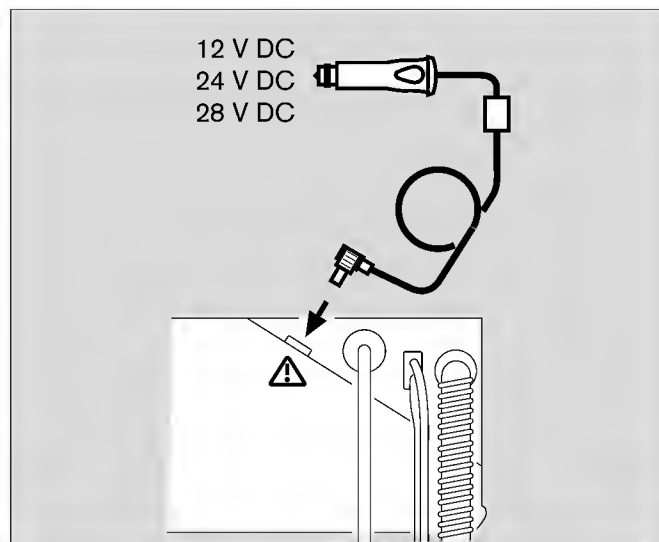
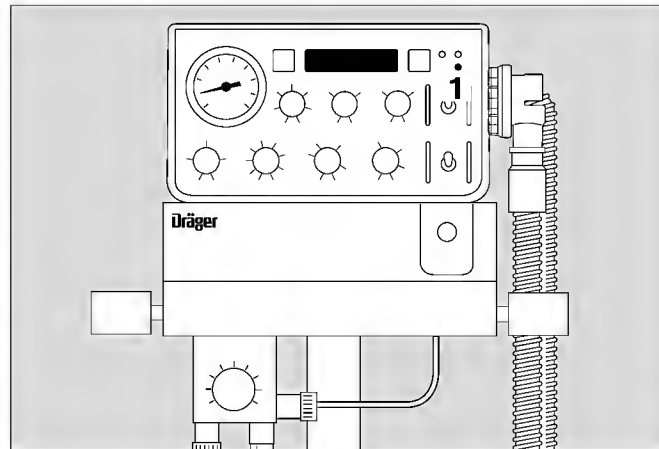
CAUTION !

Always use DC/DC converter 84 12 017 when using a DC source.

Voltage fluctuations in on-board supplies can be significant, e.g. due to varying load conditions. They may exceed the input tolerances specified for MicroVent .

The DC/DC converter conditions these types of supplies to provide a constant voltage of approximately 12 V DC.

- Attach cigarette lighter adapter plug to DC source, plug other end into external DC input jack on top of ventilator.



Gas Supply**WARNING !**

- Always use extreme caution when using oxygen!
- Oxygen intensely supports any burning!
No smoking, no open fire in areas where oxygen is in use!
- Always provide adequate ventilation in order to maintain ambient O₂ concentrations < 24 %
- Always secure O₂ cylinders against tipping, do not expose to extreme heat.
- Do not use oil or grease on O₂ equipment such as tank valves or pressure regulators. Do not touch with oily hands. Risk of fire!
- Open and close valves slowly, with smooth turns. Do not use any tools.

WARNING !

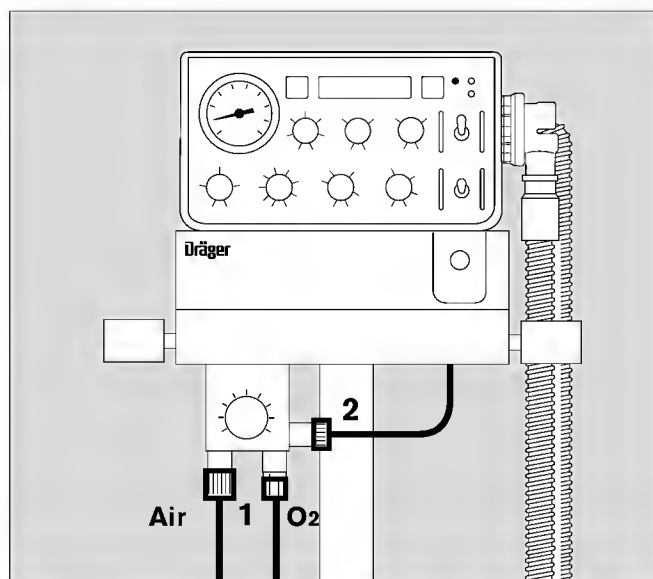
Always use medical grade oxygen that is dry and free from dust and oil. Contaminated gas may cause ventilator malfunction.

WARNING !

Do not install flow restricting valves or flow meters into the high pressure gas supply. Equipment malfunction might result.

Gas supply with O₂-Air mixer

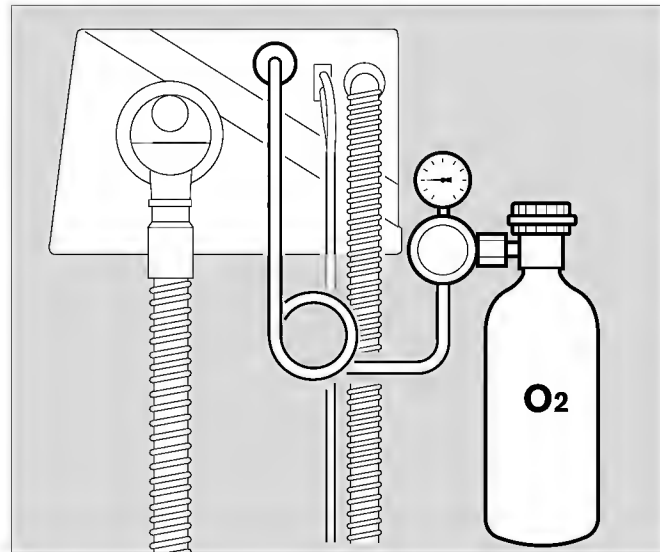
- 1 Connect air and oxygen high pressure hoses to oxygen blender.
- 2 Connect blender outlet to gas inlet on MicroVent.



O₂ Supply from an oxygen cylinder

Always use full tank (2400 psi)

- Attach pressure regulator for delivery pressure of 38 to 84 psi (= 2.7 to 6.0 bar), nominal pressure 50 psi to oxygen cylinder.
- Connect MicroVent with DISS high pressure hose to oxygen regulator.
- Open valve **slowly** and completely.



Determining gas supply in O₂ cylinder

Example:

Tank pressure according to pressure gauge on regulator:

2400 psi (165 bar)

Supply of pressurized O₂ (E-cylinder):

622 L

Estimate for expected time of operation of MicroVent

Example:

Mode CMV:

Rate = 10/min, V_T = 1 L, T_{insp.} = 3 s

Minute Ventilation:

MV = 10/min x 1 L = 10 L/min

expiratory gas consumption due to the base flow

$$= \left(1 - \frac{T_{\text{insp.}} \cdot f}{60}\right) \cdot 5 \text{ [L/min]}$$

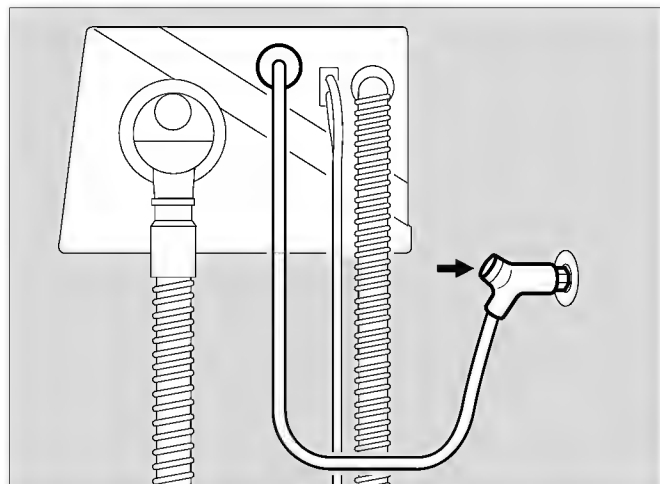
$$\text{Expected time of op.} = \frac{\text{pressur. gas supply [L]}}{(MV + 1) + \left(1 - \frac{T_{\text{insp.}} \cdot f}{60}\right) 5 \text{ [L/min]}}$$

$$T_{\text{op}} = 622 / 13,5 = 46 \text{ minutes}$$

- Close cylinder valve completely after test

Supply with oxygen from wall pipeline system


- Attach high pressure hose with DISS connector to MicroVent and connect to wall terminal with appropriate quick connect probe.



* Internal ventilator gas consumption approximately 1 L/min

NOTE: A copy of this checklist is provided on a plastic card. Keep it with the ventilator and use for checks before each use of the ventilator

Tests of Readiness for Operation

What	How	Required	Actual
Breathing system	Expiratory valve, flow sensor with elbow connector, temperature sensor, thermometer	connected	check off for "Pass" _____
	circuit, water traps, humidifier	all complete and properly in place	_____
Electrical supply	Disconnect from line power; disconnect probe for O ₂ and Air.	Self-test, Display: No ventilation Power failure Intermittent audible alarm, yellow status light is lit, red status light flashing.	_____
	Press  key.	Display: No ventilation Supply press. low	_____
	Connect to line power	green status light is on	_____
Gas supply	Connect probes for O ₂ and air; switch to CMV mode	after about 15 seconds, new display: Meas. value MV = 0 Paw low Intermittent audible alarm, red status light flashing	_____
Ventilation and check for leaks	Connect test lung.	Intermittent audible alarm stops, red status light off.	_____
	f = 10 bpm, V _T = 0.5 L, T _{insp.} = 2 s, P _{max} = 50 cmH ₂ O, MV \nleftrightarrow low = 2 L/min, MV \nleftrightarrow high = 10 L/min, PEEP = 5 cmH ₂ O, PS = 0 cmH ₂ O	Display: MV = 5 L/min I:E = 1:2 ± 1 L/min	_____
	Take PEEP reading on pressure gauge	PEEP = 5 \pm 2 cmH ₂ O	_____
Monitoring	MV \nleftrightarrow low = 7 L/min	Display: MV = 5 L/min MV low Intermittent audible alarm, red status light flashing	_____
	MV \nleftrightarrow high = 3 L/min	Display: MV = 5 L/min MV high Intermittent audible alarm, red status light flashing	_____
	P _{max} 5 cmH ₂ O below ventilation pressure	Display: MV = x.x L/min Paw high Intermittent audible alarm, red status light flashing	_____
	MV \nleftrightarrow low = 0 L/min, MV \nleftrightarrow high = 20 L/min		_____
Humidifier	Test according to its Operating Instructions		_____

Tests of Readiness for Operation

to be performed:

- each time after exchanging the patient valve
- each time after cleaning and reassembly
- at least every 6 months.

NOTE: Always log checks for documentation purposes.

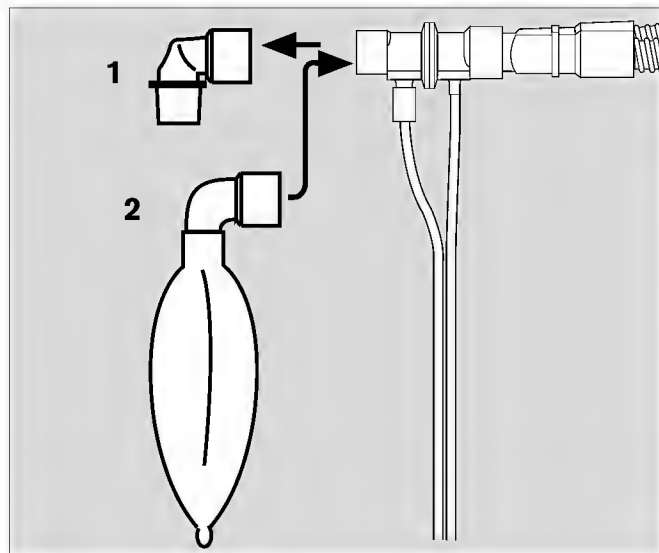
Connecting a Test Lung (part no. 84 03 201)

The test lung consists of an elbow for attaching the wye, a ET-tube adapter size 7 mm for simulation of airway resistance, and a 2 L ventilation bag for simulation of compliance.

- 1 Remove elbow from flow sensor
- 2 Insert test lung elbow to patient connector at flow sensor.

Connect gas supply:

- Open gas cylinder valve slowly and completely, or
- engage gas supply hose to wall terminal with quick connect.
- Plug mains plug into wall socket outlet.



Testing Ventilator Function

Set rotary knobs:


- 1 knob »V_T« to 0.5 L.
 - 2 knob »f« to 12 bpm;
 - 3 knob »T_{insp}« to 1.5 seconds.
 - 4 knob »P_{max}« to 60 cmH₂O.
 - 5 knob »PEEP« to 5 cmH₂O.
 - 6 Set switch for ventilator modes to »CMV«.
 - 7 Switch ventilator »ON«.
 - 8 Set alarm limits "MV" to 4 and 8 L/min.
- The ventilator will now perform an electric and pneumatic self test.
 - Display:

Self test
Software xx.xx

The bottom line displays the software version currently in use.

- The red alarm status light and the LCD backlighting will be turned on briefly.
- The audible alarm will sound twice

NOTE: For safety reasons, the audible alarm output uses two channels which are both tested during the self test. Therefore two audible alarms of the same duration will be heard.

- The green status light »« will be on continuously as long as an external power source is connected.

The self test will be completed after no more than 6 seconds

- Display:

Self test O.K.

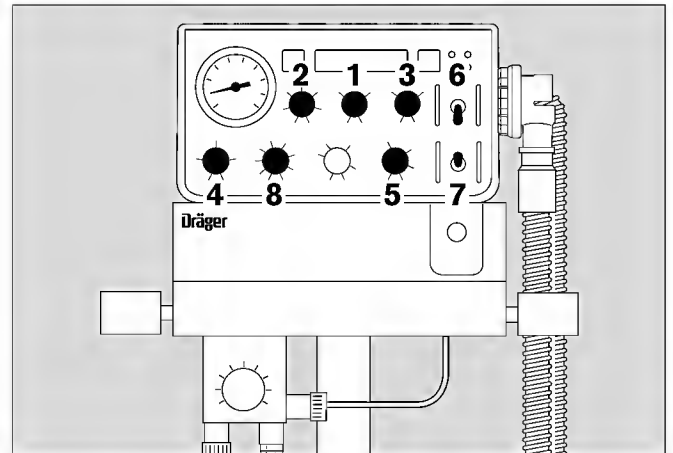
- MicroVent will now ventilate the test lung with the preset ventilation pattern.
- The pressure gauge should alternate between a consistent inspiratory pressure and an endexpiratory pressure of about 5 cmH₂O.
- The display should show a minute volume of:

CMV MV = 6.0

(Tolerance: ± 1.0 L/min)

If the value is outside the tolerance:

- Replace flow sensor



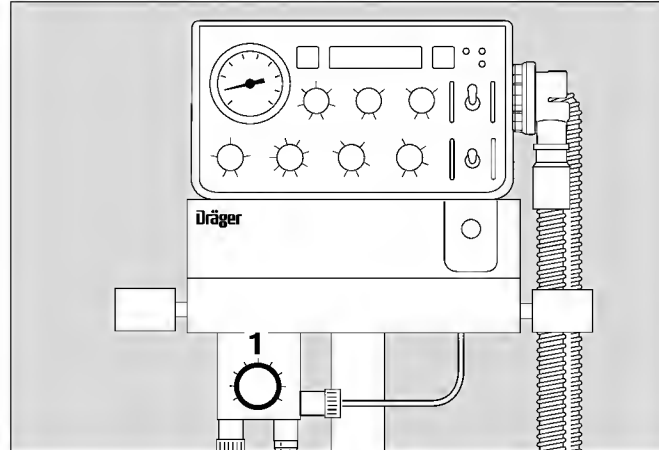
Tests of Readiness for Operation

Testing O₂ Concentration Testing Minute Volume Monitoring

Testing O₂ Concentration

using an independent, external oxygen analyzer

- 1 Set mixer to 50 vol.% O₂.
- Measured O₂ concentration should be in the range of 50 ±5 vol.%.




Testing Minute Volume Monitoring

- 1 Set lower alarm limit to 7 L/min.
- Display and intermittent audible alarm

CMV MV = 6.0
MV low

- 1 Reset lower alarm limit to 4 L/min. The intermittent audible alarm should stop

To clear display:

- 2 Press  key.


- 1 Set upper alarm limit to 5 L/min.

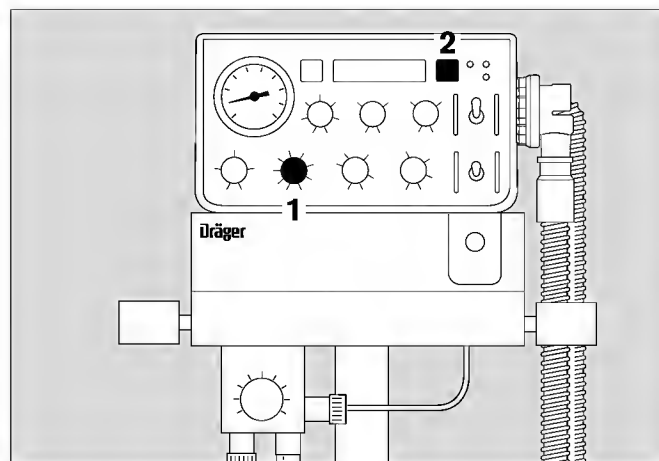
- Display and intermittent audible alarm

CMV MV = 6.0
MV high

- 1 Reset upper alarm limit to 8 L/min. The intermittent audible alarm should stop

To clear display:

- 2 Press  key.



Testing PEEP

Testing »Paw high« Alarm

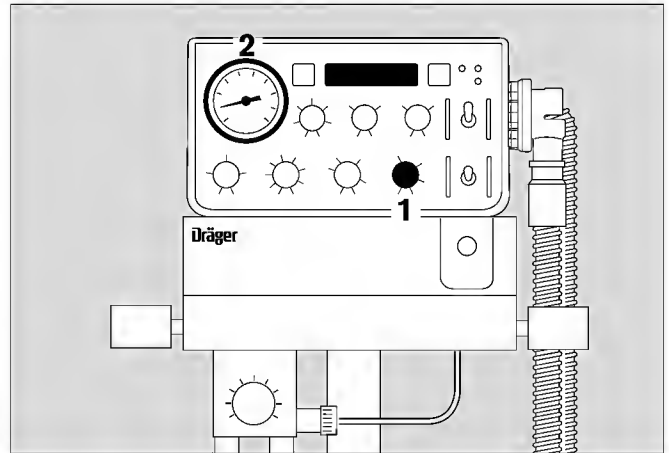
Tests of Readiness for Operation

Testing PEEP

- 1 Set knob »PEEP« to 0 cmH₂O.
- 2 Value on pressure gauge at end of expiration:
0 cmH₂O \pm 2 cmH₂O tolerance.

- 1 Set knob »PEEP« to 10 cmH₂O.
- 2 Value on pressure gauge at end of expiration:
10 cmH₂O \pm 2 cmH₂O tolerance.

- 1 Set »PEEP« knob back to 5 cmH₂O



Testing »Paw high« Alarm

Set rotary knobs:


- 1 knob »V_T« to 1.0 L,
 - 2 knob »f« to 5 bpm,
 - 3 knob »T_{insp}« to 3 seconds,
 - 4 knob »P_{max}« to 40 cmH₂O.
- Hold test lung squeezed and observe pressure gauge.
 - At an airway pressure of 36 to 40 cmH₂O, the ventilator switches to expiration, the test lung empties out.
 - The red alarm status light starts blinking, the display shows:

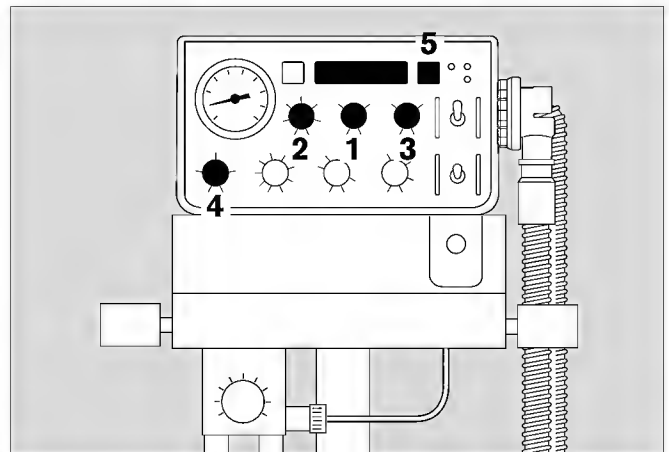
Paw high

an intermittent audible alarm is set off.

- Let test lung expand again.
- The intermittent audible alarm will stop.

To clear display:

- 5 Press  key.



Tests of Readiness for Operation

Testing »Paw low« Alarm
Testing »Main supply« Alarm
Testing SIMV Synchronization

Testing »Paw low« Alarm

Using the previous settings:


- Remove test lung
- After about 15 seconds, the red alarm status light should be flashing and the display showing:

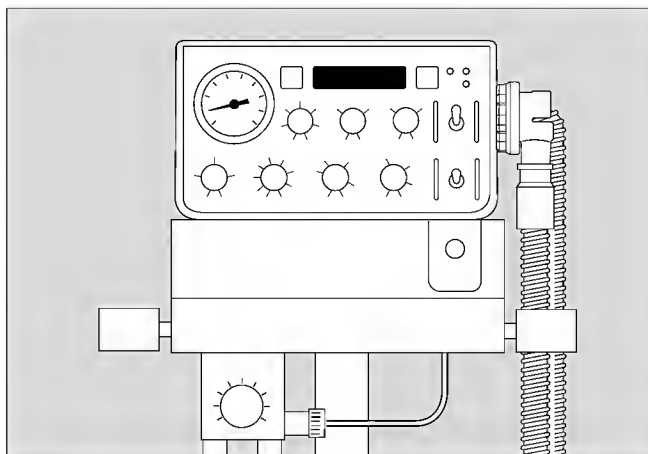
CMV MV = 0
Paw low

The intermittent audible alarm should also be set off.

- Re-attach test lung.
- The intermittent audible alarm will stop after about 1 minute.

To clear display:




- Press  key.



Testing »Main supply« Alarm

Using the same setting.




Interrupt external power supply:

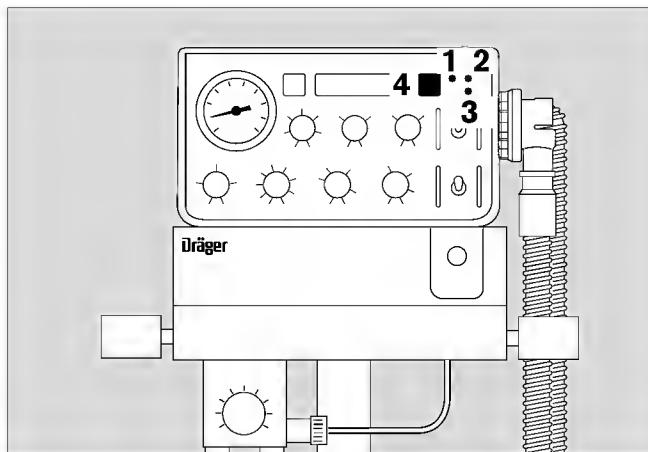
- 1 The red light  flashes.
- 2 The green light  goes out.
- 3 The yellow light  is lit.

Display:

main supply down

The repeated sound should start again. The ventilator continues to operate with the internal power supply.

- 4 Press  key. The repeated sound should stop and the message disappear.
- Reconnect external power supply.
 - The yellow light  goes out and the green light  is lit.

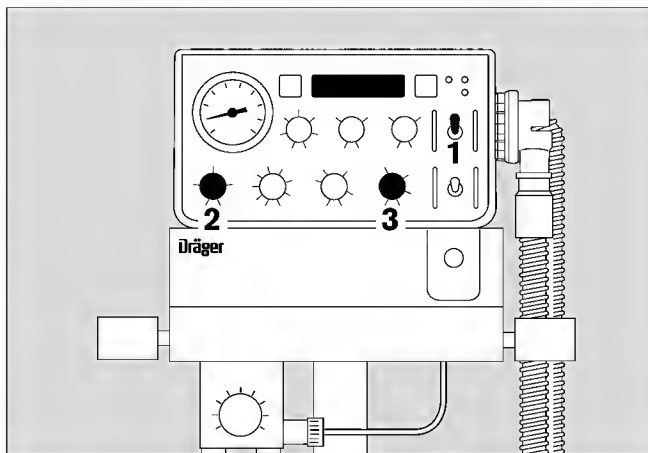


Testing SIMV Synchronization

- 1 Set switch for ventilator modes to SIMV/CPAP,
 - 2 knob »Pmax« to 60 cmH₂O,
 - 3 knob »PEEP« to 10 cmH₂O.
- Simulate several spontaneous inspirations by squeezing and subsequent releasing of test lung.
 - Within approximately 5 seconds, a synchronized ventilator breath should occur. Synchronizing was successful when a *-symbol shows in the display behind the measured value.

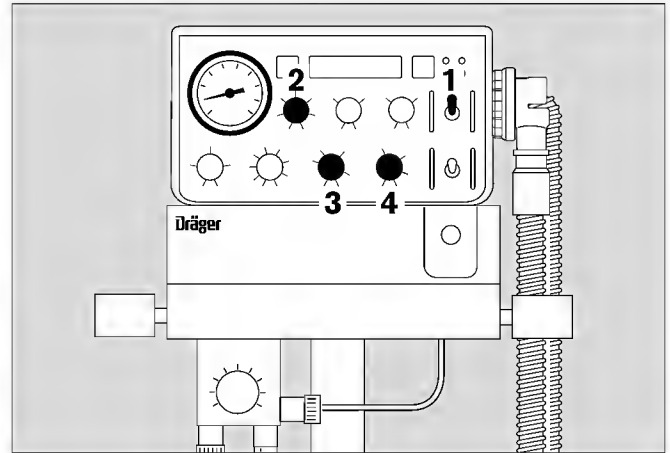
Example:

MV = 6.0 L/min *




Testing Pressure Support Ventilation

- 1 Set switch for ventilator modes to SIMV/CPAP,
 - 2 knob »f« to 0 bpm,
 - 3 knob »PS« to 25 cmH₂O,
 - 4 Knob »PEEP« to 10 cmH₂O,
- Squeeze test lung a little, release and observe diameter:
The airway pressure should rise to 25 cmH₂O \pm 3 cmH₂O, (pressure support) and then drop to 10 cmH₂O \pm 2 cmH₂O (PEEP).



WARNING !

Ventilator is ready for operation only after all tests were performed successfully.

- On / Off switch to 0 (OFF).
- Press  key to confirm.
- Remove test lung, re-attach elbow connector.

Operation

WARNING !

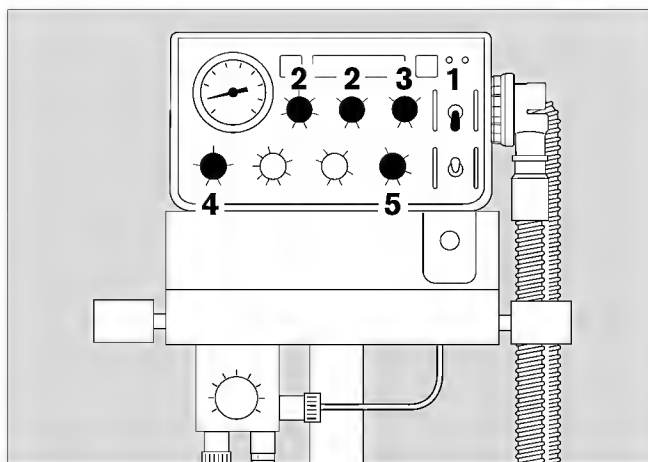
Always use ventilator that has been cleaned and disinfected and has been successfully tested to be ready for operation.

Controlled Mandatory Ventilation (CMV)

For ventilator rates of 5 to 60 bpm.

NOTE: During CMV, the MicroVent ventilator limits the minimum ventilator rate to 5 bpm.

- 1 Set switch for ventilator modes to CMV
- 2 Set knobs »f« and »V_T«.
- 3 Set knob »T_{insp.}«.
- 4 Set knob »P_{max}« initially to 60 cmH₂O.
- 5 Set knob »PEEP« initially to 0 cmH₂O.



- 6 Set O₂ concentration on blender.
 - 7 Set alarm limits for minute volume.
 - 8 On/Off switch to »ON«.
- Display:

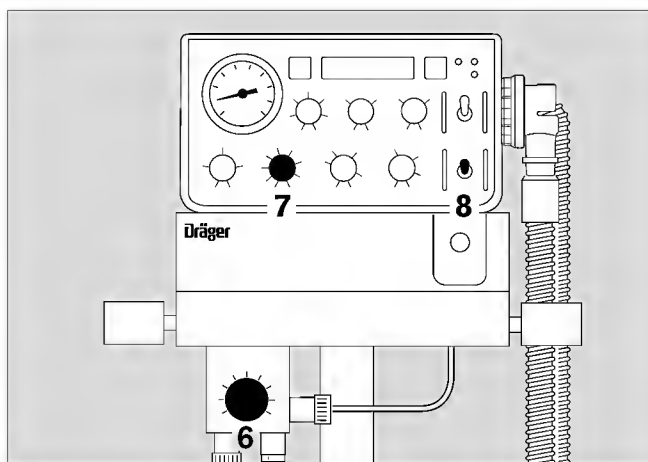
Self-test
Software xx.xx

When the patient has been connected:

- Check display of minute ventilation and re-adjust for the specific patient.

WARNING !

Observe pressure gauge in order to identify improper ventilation. Operator must always be ready to intervene if alarm indicates a situation dangerous to the patient.



If the expiratory minute ventilation is less than 2 L bpm, display will show:

1 Display:

CMV MV = 0

2 Evaluate max. airway pressure Paw from pressure gauge.

3 Set knob »Pmax« to approximately 10 cmH₂O above max. airway pressure.

If the airway pressure reaches the pressure limit »Pmax«, the ventilator will immediately switch to expiration and generate an alarm in order to protect the patient.

1 Alarm message:


Paw high

In this situation, the ventilator is unable to deliver the preset tidal volume.

When airway pressure is too high and alarm »Paw high« has been set off:

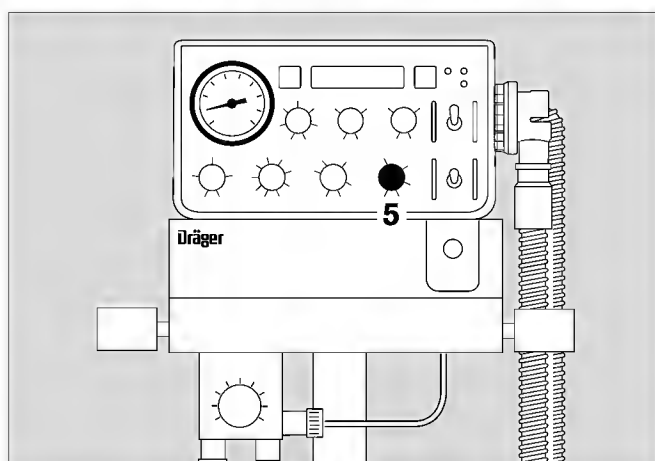
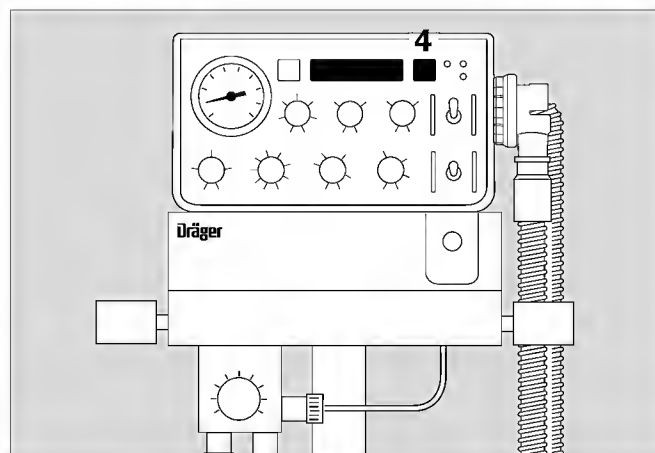
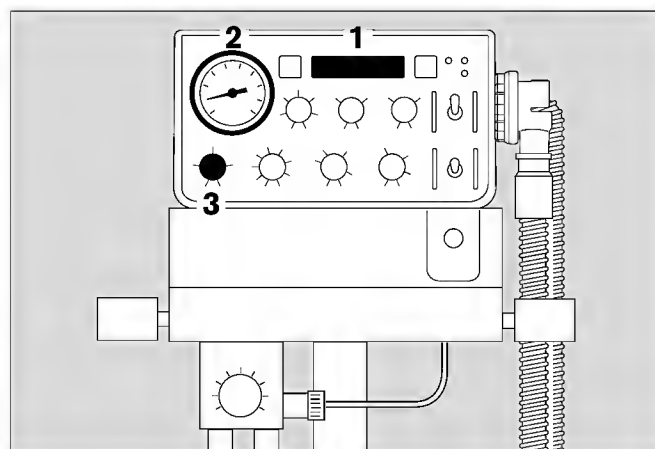
- Check position of ET-tube.
- Check patient airways, suction if necessary.
- Verify that ventilator circuit is not kinked.

To clear alarm message from display:

4 Press  key.

Applying PEEP:

1 Set knob »PEEP« to desired value and check result on pressure gauge.




Assist Control Ventilation(A/C)

Under A/C, mandatory ventilator breaths can be triggered within a time window to synchronize them with the patient's spontaneous breathing.


The ventilator rate is then higher than the rate set.

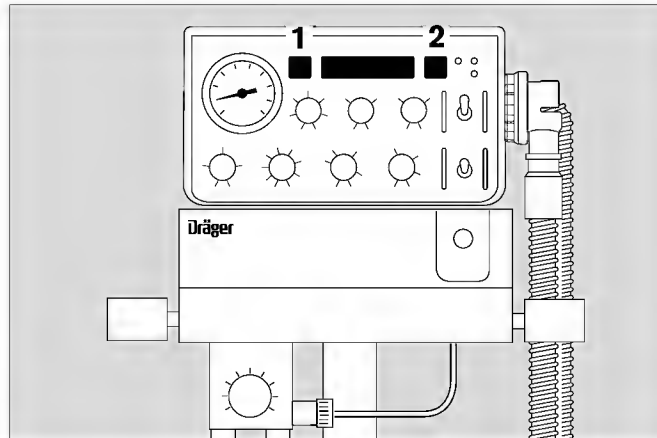
If spontaneous breathing does not occur, the ventilator applies mandatory breaths at the set (minimum) rate.

- First set ventilation as for CMV, see page 30, then:

- 1 using  key, forward to display message:

CMV -> A/C

- 2 Confirm using  key; the ventilator is now in A/C mode of ventilation.



Synchronized Intermittent Mandatory Ventilation (SIMV)

SIMV is a combination of mandatory ventilation and spontaneous breathing. It enables the patient to breathe spontaneously in between mandatory ventilator breaths. If the patient does not inspire spontaneously within a certain time window, the ventilator will apply an unsynchronized mandatory breath.

For low rates of mandatory ventilator breaths, the trigger window should not be longer than 5 seconds in order to guarantee a minimum expiratory time of 0.5 seconds. The size of the trigger time window should be reduced with increasing mandatory ventilator rates.

With synchronization, the mechanical ventilator breath is applied during the preset time window to coincide with the patient's inspiratory effort. The rate of the mechanical ventilator breaths remains constant.

An asterisk (*) in the display indicates that synchronization is successful.

For rates of 2 to 60 bpm

Tidal volume (V_T), ventilator rate, and inspiratory time (T_{insp}) determine the delivery of mandatory breaths.

- 1 Set switch for ventilator modes to SIMV/CPAP.

Adjust pattern of mandatory ventilator breaths by setting:

- 2 knob » V_T «
knob »f«,
knob » T_{insp} «

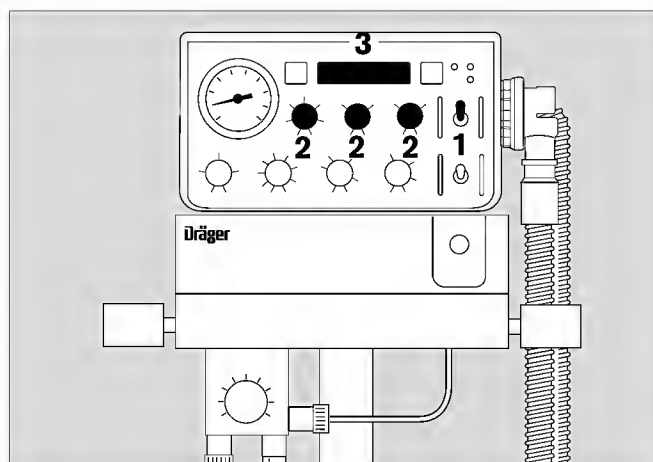
NOTE: Preferred rates are less than 10 bpm. This will allow sufficient time for a patient's spontaneous breathing

If the expiratory minute volume is less than 2 L/min:

- 3 display shows:

SIMV MV = 0

- When spontaneous breathing returns, reduce ventilator rate with knob »f«.



For rate settings below 2 bpm, switch to CPAP

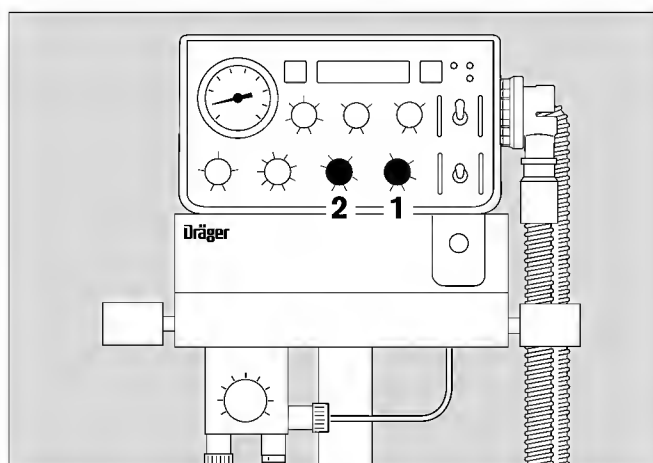
Set continuous positive airway pressure:

- 1 using knob »PEEP«.

You may provide pressure support during spontaneous breathing:

- 2 set knob »Press. Supp.« higher than PEEP, as appropriate. Pressure support will then be active according to the difference in pressure levels between Press. Supp. and PEEP.

NOTE: When Press. Supp. is set lower than PEEP, no pressure support is provided.



Continuous Positive Airway Pressure (CPAP) / Pressure Support

WARNING !

Use CPAP mode only for patients who have sufficient spontaneous breathing.

Checking for sufficient spontaneous breathing on pressure gauge:

Patient must be capable of generating a negative pressure of at least 2 cmH₂O during inspiration.

- 1 Set knob »f« to 0.
- 2 Set switch for ventilator modes to SIMV/CPAP.
- 3 Set knob »PEEP« to desired level of positive airway pressure.

NOTE: When set values are below 3 cmH₂O, a disconnection alarm is generated. Disconnections are detected when pressure falls below the absolute threshold of 3.0 cmH₂O or when there is a sudden drop in pressure of more than 5 cmH₂O during CPAP.

For pressure support:

- 4 set knob »PS« higher than PEEP, as appropriate. Pressure support will then be active according to the difference in pressure levels between Press. Supp. and PEEP.

NOTE: When Press. Supp. is set lower than PEEP, no pressure support is provided

If apnea occurs, apnea ventilation is switched on at $f = 8$ bpm:

- 5 Use knob »V_T« to set tidal volume and
- 6 Use knob »T_{insp}« to set inspiratory time.

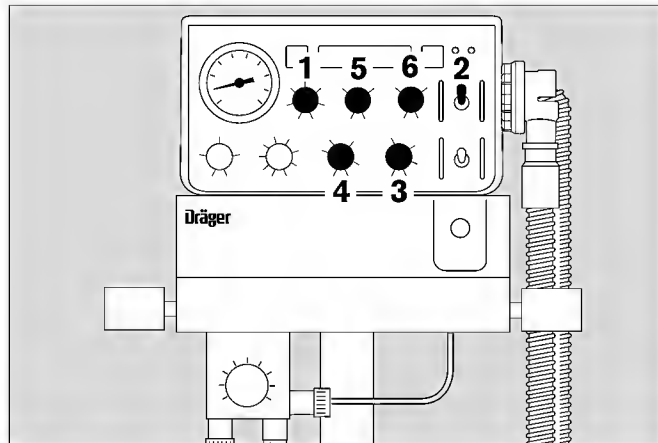
When no breaths have been detected by the ventilator for 15 seconds, display shows warning message:

Apnea

continuous audible alarm begins, red alarm light starts flashing.

If ventilator does not detect an inspiratory effort after another 15 seconds, apnea ventilation will begin - using a fixed ventilator rate of 8 bpm and the values set for V_T and T_{insp}. The display will then show:

Apnea ventilation



Continuous audible alarm and flashing of red alarm status light both continue.

When spontaneous breathing is insufficient:

- switch to SIMV or CMV.

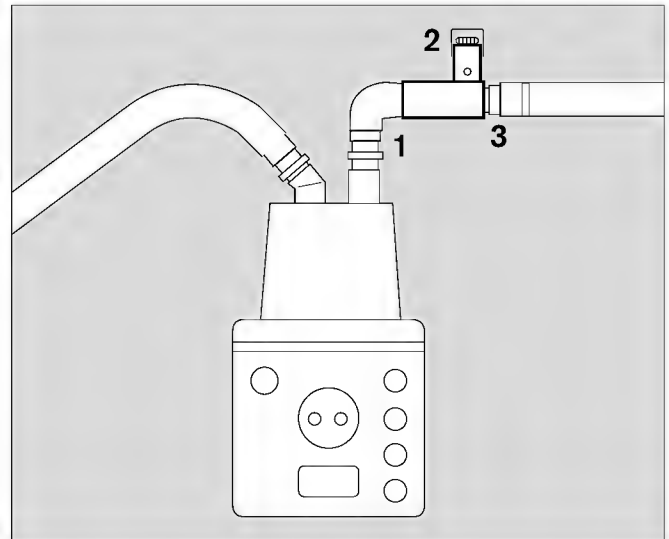
To switch off apnea ventilation:

- press  key twice.

Pressure-limited ventilation

Use optional pressure limiting valve 8405390!

- Draw ventilation hose off twin nozzle of the humidifier.
 - Draw elbow connector (with twin nozzle) off the humidifier connection.
- 1 Plug twin nozzle (with elbow connector) into the humidifier connection.
 - 2 Plug pressure limiting valve onto elbow connector with adjusting screw pointing upwards.
 - 3 Plug ventilation hose onto nozzle of pressure limiting valve.
- Set ventilation as described for IPPV/SIMV mode.
 - Set inspiratory pressure by means of adjusting screw on pressure limiting valve and check on pressure gauge.
 - Check set tidal volume V_T .
 - Correct alarm limits for the minute volume MV and max. airway pressure P_{aw} if necessary.



Displaying Measured Ventilation Parameters

Both ventilation mode set and expiratory minute volume (MV) are displayed continuously in the top line of the LCD screen.

In the bottom line, different ventilation parameters can be displayed, depending on the current mode of ventilation (see the following examples):

During CMV

Inspiratory Flow	FLOW = 30.0 L/min
I:E-ratio	TI:TE = 1:2
Peak pressure	PEAK = 20 cmH2O
Mean pressure	MEAN = 15 cmH2O
Endexp. pressure	PEEP = 5 cmH2O
Breathing rate	Frequency = 10 bpm


During SIMV

Inspiratory Flow	FLOW = 30.0 L/min
Peak pressure	PEAK = 20 cmH2O
Mean pressure	MEAN = 15 cmH2O
Endexp. pressure	PEEP = 5 cmH2O
Breathing rate	Frequency = 10 bpm
Tital volume	VT = 450 ml

During CPAP

Positive airway pressure	CPAP = 8 cmH2O
Peak pressure	PEAK = 20 cmH2O
Mean pressure	MEAN = 15 cmH2O
Breathing rate	Frequency = 10 bpm
Tidal volume	VT exp. = 450 mL

Switching between measured parameter values to be displayed:


- Briefly press  key.

End of Operation

After disconnecting patient:

- 1 Switch ventilator »OFF«.
Display:

No ventilation
Confirm !

- 2 Confirm using  key.

With oxygen supply from a cylinder:

- Completely shut cylinder valve.

With oxygen supply from wall oxygen system:

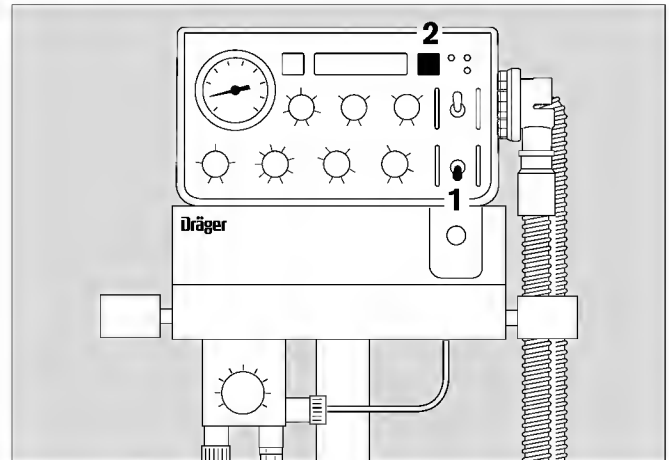
- Disconnect high pressure hose quick connect probe from wall terminal.

Storage of ventilator for an extended period of time

When MicroVent is not going to be used for more than 2 months:

- Remove battery pack with alkaline batteries (where applicable)

NOTE: Rechargeable batteries may remain in the ventilator. **Check batteries monthly.**




In Case of Loss of Electric Power

NOTE: In case of an AC power failure (blackout), automatic ventilation, volume measurement and alarms continue to operate.

If this situation has occurred, ventilator display shows:

main supply down

- Acknowledge = press  key.

The ventilator can be operated for up to 2 hours without an electrical power supply.

- Make sure that an electrical power supply is re-established in good time.

WARNING !

Automatic patient ventilation, volume measurement, and alarms are not functional in case of a total loss of electric power!

Spontaneous breathing through the integrated demand valve, however, is still possible in that situation,



Immediately start ventilating patient with independent manual ventilation device (resuscitation bag) using PEEP and/or increased inspiratory oxygen concentration where necessary and appropriate.

Time Limits for Battery Powered Operation


With a fully charged NiCd battery pack, the MicroVent ventilator can be operated for approximately 2 hours.

NOTE: The 2 hour estimate may have to be reduced when loss of battery capacity has occurred over time.

With new alkaline batteries, the MicroVent ventilator can also be operated for approximately 2 hours.

- 1 The green light  is lit when MicroVent is being operated with AC adapter.
- 2 The yellow light  is lit when MicroVent is being operated from an internal NiCd pack or alkaline battery pack.

When operating with no mains adaptor and with only NiCd pack or battery pack:

- 3 Press  key after switching on.

NOTE: It is not possible to operate MicroVent without an internal power supply (NiCd pack or battery pack).

When batteries near the end of capacity, the display will show, respectively:

Charge NiCd

or

Change bat.

Approximately 10 minutes of operation remain at the time of these messages.

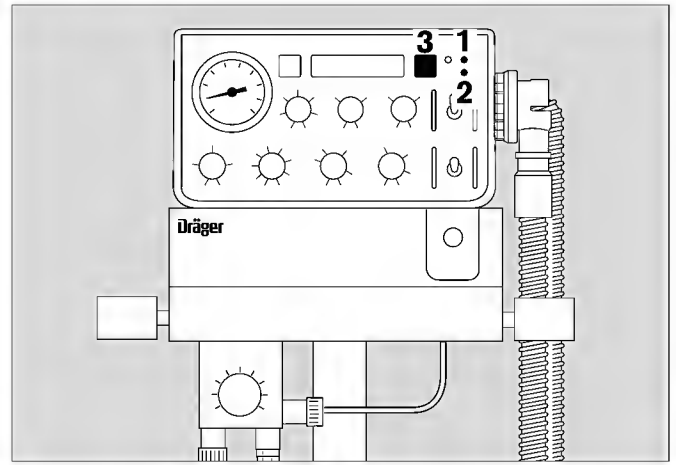
NOTE: In order to save power, the display light cannot be switched on during this time.

CAUTION !

The internal battery pack will last for up to 2 hours of operation. Keep additional, fully charged battery packs on hand for backup if external sources might not be available for more than 2 hours

CAUTION !

When exchanging the internal battery pack during operation, always assure that ventilation can be provided with an independent ventilation device (resuscitation bag) while the MicroVent is disconnected from power.



If necessary:

- ventilate patient with resuscitation bag,
- install new battery pack (see page 17),
or connect ventilator to external electrical power
(see pages 17-20).

Alarms

In case of an alarm:


- The red alarm status light will be lit / blinking, and
- an audible alarm will be generated:
 - as a continuous or intermittent audible alarm (WARNINGS)
 - or
 - as a 30 second chirp (Advisory), and
 - an alarm message will be displayed on the 2nd line of the display.
- Evaluate audible alarm:
 - either: continuous or intermittent audible alarm
= urgent, immediate action required!
 - or: every 30-seconds = advisory reminder

WARNING !

Continuous or intermittent audible alarms require immediate operator attention to avert or to prevent development of situations with the possibility of patient injury.

- Read alarm message in display, correct condition using the guidelines from chapter "Troubleshooting" on pages 50-52.


NOTE: The audible alarm may be silenced for 2 minutes during alarm conditions:

- Press  key.
The audible alarm will sound again after 2 minutes if the same alarm condition persists and in case of a new alarm condition of higher priority.

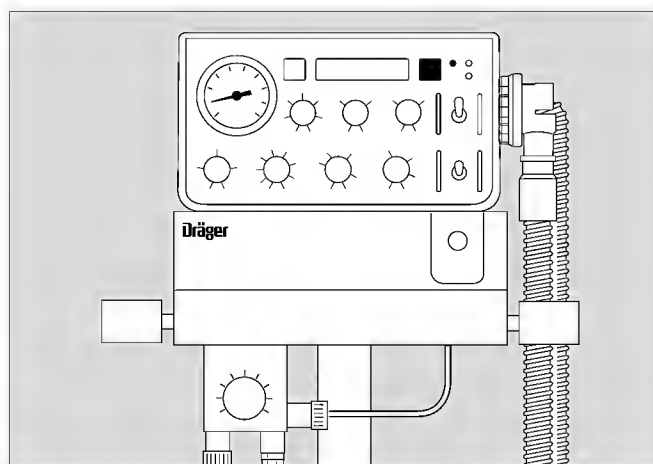
When an alarm condition has been corrected:

- the alarm status light will no longer be on,
- the audible alarm will be off.

Clearing an alarm message from the display:

- Press  key.

NOTE: An alarm message can only be reset when the condition causing it has been corrected. A message that has not been reset yet will, however, be overwritten by a new message of higher priority.



Care

- Always clean and disinfect expiration valve and (reusable) patient circuit after each use.
- Clean ventilator and high pressure hoses according to visual check of cleanliness and/or established hospital procedures.

Disassembly

WARNING !

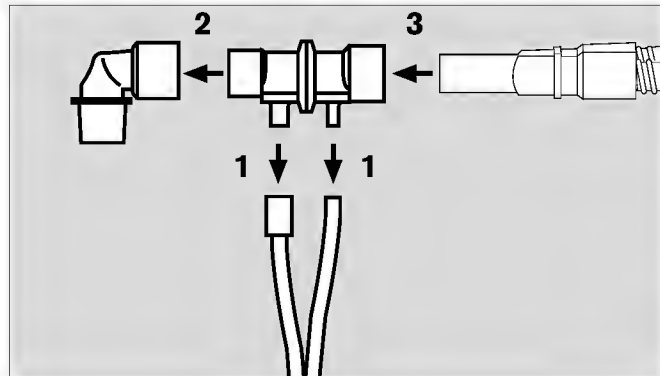
Always follow accepted hospital procedures for handling equipment contaminated with body fluids.

- 1 Remove pressure sensing hoses (flow measurement) from flow sensor.
- 2 Pull elbow connector from flow sensor.
- 3 Disconnect flow sensor from wye.

CAUTION !

Prevent any foreign objects from getting into the flow sensor.

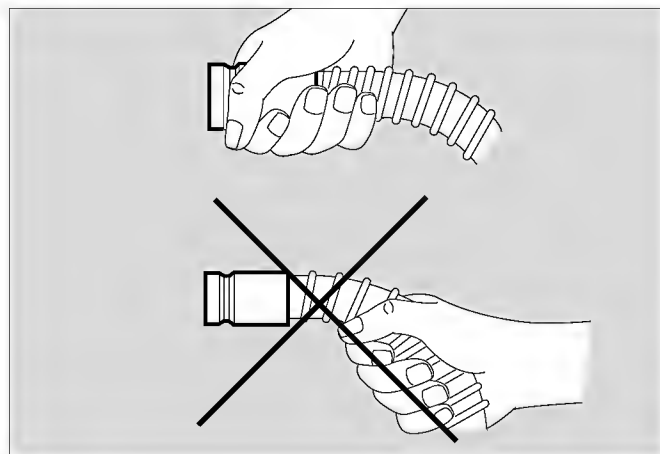
Do not use pressurized air for cleaning, the orifice membrane inside the flow sensor may become damaged.



- Empty water traps in patient circuit.
- Disconnect patient circuit from nozzles

CAUTION !

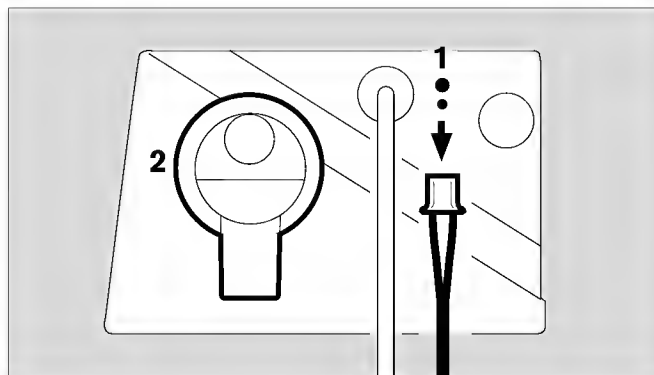
When removing patient circuits, always handle at end fittings! Otherwise, support helix may be torn at end fitting or hose and fitting could come apart.



Disassembling the Patient Valve

Disassembling the Humidifier

- 1 Disconnect flow-measuring hoses from nipples on ventilator.
- 2 Disconnect expiratory valve from ventilator.

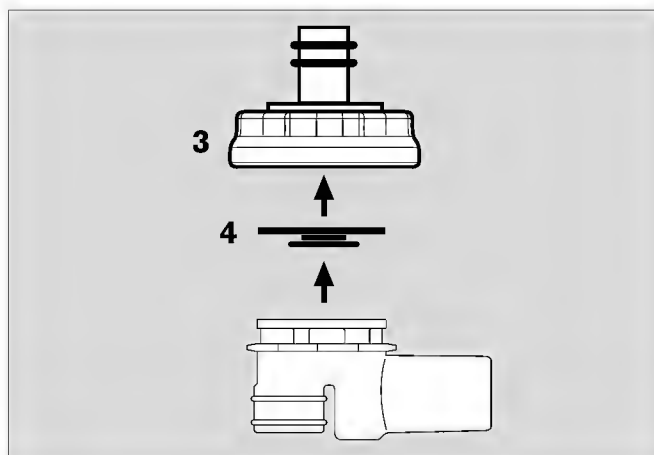


Disassembling the Patient Valve

- 3 Turn lid 90° counterclockwise = disengage and remove.
- 4 Remove silicone membrane.
- Do not further disassemble the patient valve!

CAUTION !

Prevent any foreign objects from getting into the ventilator valve.
Be careful not to damage the silicone membrane or other disassembled parts.



Disassembling the Humidifier

Always follow Operating Instructions of humidifier used when cleaning and disinfecting.

Disinfecting / Sterilizing

CAUTION !

Certain components of the ventilator consist of materials that are sensitive to certain organic solvents sometimes used for cleaning and disinfecting (e.g., phenols, halogen releasing compounds, oxygen releasing compounds, strong organic acids, etc.). Exposure to such substances may cause damage that is not always immediately recognized. Sterilization of the ventilator itself with ethylene oxide (EtO) is also not recommended.

CAUTION !

Follow all accepted hospital procedures for disinfecting parts contaminated by body fluids (protective clothing, eyewear, etc.).

To prevent any damage, we recommend that only detergents and disinfectants are used that are compatible with the materials used in the ventilator and its accessories, e.g. surface disinfectants on the basis of aldehydes, alcohol, or quaternary ammonium compounds for disinfection of the main unit.

Ensure that all disinfectants are registered with the U.S. Environmental Protection Agency for use as intended. Always follow the instruction labels specifically with respect to prescribed concentrations and the necessary exposure times.

Wipe Disinfection:

Use for ventilator, circuit support arm, mobile stand, and high pressure hoses.

- Disinfect by wiping all surfaces following manufacturer's instructions of disinfectant used regarding concentrations and application.

Bath disinfection:

Use for disassembled parts of the patient valve, flow sensor, ventilator circuit (where applicable), pressure sensing hoses for flow measurement.

- Disinfect by immersion in disinfectant solution, following manufacturer's instructions. Move parts thoroughly.

CAUTION !

Do not use hard brush for cleaning
Prevent any foreign objects from getting into the patient valve.

- Remove parts after the recommended exposure time and rinse thoroughly with distilled water.
- Shake water out and let parts dry completely before reassembling.

WARNING !

Water remaining in the ventilator valve or in the pressure sensing lines for flow measurement may cause ventilator malfunction.

Sterilization procedures

Where referenced in established hospital procedures

- Disassembled parts of the patient valve, flow sensor, ventilator circuit (where applicable), pressure sensing hoses for flow measurement may be steam autoclaved at 273 °F (134 °C).

Accessories

Cleaning and disinfection procedures for humidifier and oxygen analyzer should be performed according to their respective Operating Instructions

After cleaning and disinfecting

- Re-assemble (page 15),
- connect power and gas supply (pages 17,21),
- check readiness for operation (page 23).

Inspection and Maintenance

WARNING !

To avoid any risk of infection, clean and disinfect ventilator and accessories before any maintenance according to established hospital procedures - this applies also when returning ventilators or parts for repair.

Preventive Maintenance

WARNING !

Preventive Maintenance work on the MicroVent ventilator may be performed by trained and factory authorized staff only.

Refer to schedule to the right for preventive maintenance intervals:

WARNING !

Treatment of batteries:
Do not throw into fire! Do not force open!
danger of bodily injury.

Follow all local, state, and federal regulations with respect to environmental protection when disposing of batteries.

For exchanging the NiCd battery pack, please refer to pages 17-18, "Preparation".

Scheduled safety checks	every 6 months
Inspection and prev. maint.	every 6 months
Internal alkaline batteries	replace, if message »Bat. discharged« or »Change bat.« is displayed
Internal NiCd battery pack	replace, if message »defective NiCd« is displayed, every 2 years at the latest
Pressure reducer overhaul	every 6 years
Gas mixer overhaul	Service after 3 years by trained service per sonnel

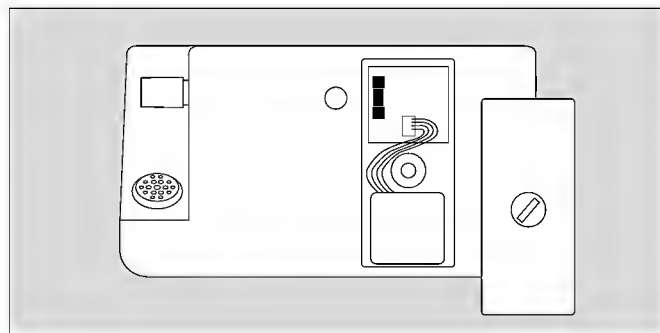
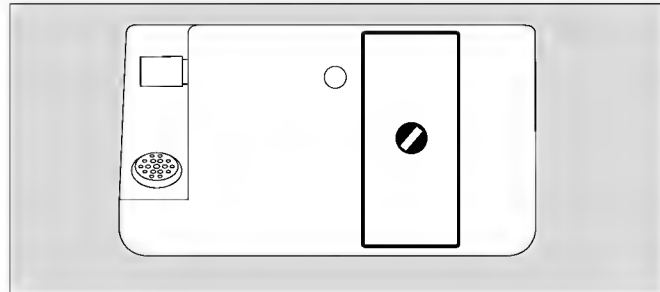
Inspection and Maintenance

Changing a Fuse In Case of Ventilator Malfunction Extended Storage

Changing a Fuse

When all ventilator functions have failed

- Undo screw in lid of battery compartment (use coin) and remove lid.
- Take out defective fuse (use screwdriver to lift)
- Insert new fuse (T1L 250V IEC 127-2) securely into holder.
- Reinstall lid and tighten screw



In Case of Ventilator Malfunction

WARNING !

Never operate the ventilator if it has suffered physical damage or does not seem to operate properly. In this case always refer servicing to properly trained and factory authorized service personnel.

WARNING !

If, in case of damage to the ventilator, the glass of the LCD screen is broken, a liquid chemical may be released that should not come into contact with the skin. In case of contamination, wash off with soap immediately.

Extended Storage

When MicroVent is not going to be used for more than 3 months:

- Remove battery pack with alkaline batteries (where applicable)

NOTE: Rechargeable batteries may remain in the ventilator. Check batteries monthly.

Customer Service Mode

Customer Service Mode



- for selecting the language for display texts
- for checking the machine status and machine functions
- for switching ON / OFF the high rate-Alarm

The information provided by these checks allows DrägerService to draw conclusions as to the cause of a fault.

The display texts for customer service mode appear in English.

Select Customer Service Mode

Disconnect MicroVent from patient.

- 1 On / off switch to **0** (OFF).
- 2 "f" rotary knob to max. = 60 / min.
- 3 "Vt" rotary knob to max. = 1.5 L
- 4 Press  and  keys and hold down

While holding down these keys:

- 1 On / off switch to **I** (ON)

MicroVent performs self-test, then display:



**Customer
Service Mode**

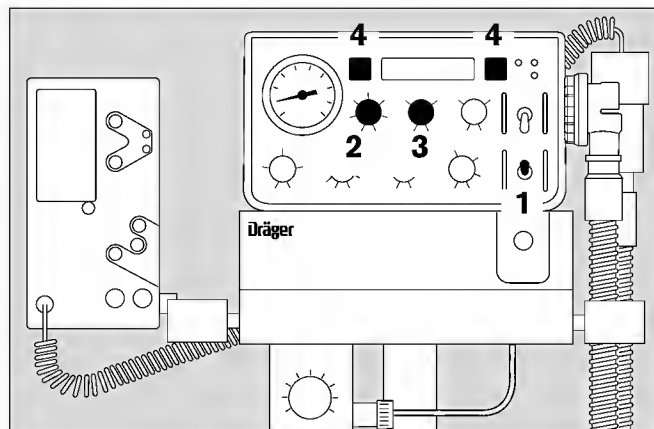
- Release keys.

Display:

Adjust language
<- **001** +>

Activate

- 4 Confirm = briefly press  and  keys **simultaneously**.



Customer Service Mode

The language for the display texts is selected via mode step 001.

MicroVent is supplied with English texts as standard.

The following can be selected as alternatives:

German	(deutsch)
International English	(english)
International French	(français)
Spanish	(español)
Finnish	(suomeksi)
Portuguese	(portuguese)
Italian	(italiano)
American English	(american English)
French	(français)
Dutch	(nederlands)



Select language:

- Briefly press  or  key.

Confirm language:

- Briefly press  and  keys simultaneously.

Select another mode step:

- Increment by pressing  key.
- Decrement by pressing  key.

Activate mode step:

- Briefly press  and  keys simultaneously.

Confirm:

- Briefly press  and  keys simultaneously.

Other mode steps:

002 Check medical gas supply:

Pressure high

or

Pressure low

003 Test switch for ventilation modes:

Pos. IPPV/SIPPV

Pos. SIMV/CPAP

004 Check settings of rotary knob for minute volume alarm limits

MV-low = XX.XX
MV-high = XX.XX

005 Sound source test, lamp test, display test

INFO TEST ON
RESET TEST OFF

006 Check settings of rotary knobs for "f", "V_T", "T_{insp}", "P_{max}"

F = XX.XX VT = X.XX
Ti = X.XX P = XX.X

007 Switching ON / OFF high rate alarm

Tachypnea alarm
ACTIVE

or

Tachypnea alarm
INACTIVE

Exit Customer Service Mode:

- On / off switch to 0 (OFF)

Troubleshooting

Troubleshooting

Alarm screen messages are displayed hierarchically, i.e., in order of priority.

If, for example, two faults are detected simultaneously, the more serious fault will be displayed.

The table below is intended as a quick reference for recognizing and correcting causes of alarms.

NOTE: The messages in the table are listed in **alphabetical** order.

Problem / Message	Likely causes	Remedy
AC power failure	No external supply available.	Connect to electrical power supply as soon as possible.
Apnea Alarm status light flashing, intermittent audible alarm.	Patient's spontaneous breathing in CPAP mode insufficient.	Switch to CMV or SIMV.
Bat. discharged Alarm status light flashing, intermittent audible alarm.	Battery discharged; no external power supply.	Replace battery pack with new pack or connect to external power supply.
Change bat. Alarm status light flashing, single beep every 30 seconds. Display illumination cannot be switched on.	Battery pack will be discharged within a few minutes, external power supply not connected.	Replace battery pack with new pack or connect to external power supply.
Charge NiCd Alarm status light flashing, single beep every 30 seconds. Display illumination cannot be switched on.	NiCd pack will be discharged within a few minutes, external power supply not connected.	Replace rechargeable battery pack with a fully charged NiCd pack or connect to external power supply.
Check settings Alarm status light flashing, intermittent audible alarm.	Settings outside ventilator performance limits; required flow is less than 10 L/min or greater than 80 L/min.	Adjust set parameters; e.g. f , V_T or T_{insp} .
Defective NiCd	Ventilator connected to external power supply. Defective NiCd pack.	Replace rechargeable battery pack with a new NiCd pack.
Flow measurement INOP	Flow measurement not operable. Signals from flow measurement are not used for alarms.	Ventilation may be continued. After shutdown, call DrägerService.
Leakage Alarm status light flashing, intermittent audible alarm.	The measured expiratory minute volume has fallen to about 40 % below inspiratory minute volume.	Correct leakage in patient system and/or in ET-tube, if necessary.
Loss of CPAP	CPAP drops suddenly by more than 5 cmH ₂ O or circuit connections leaking.	Change CPAP pressure in small increments only. Make sure connections are leak free.

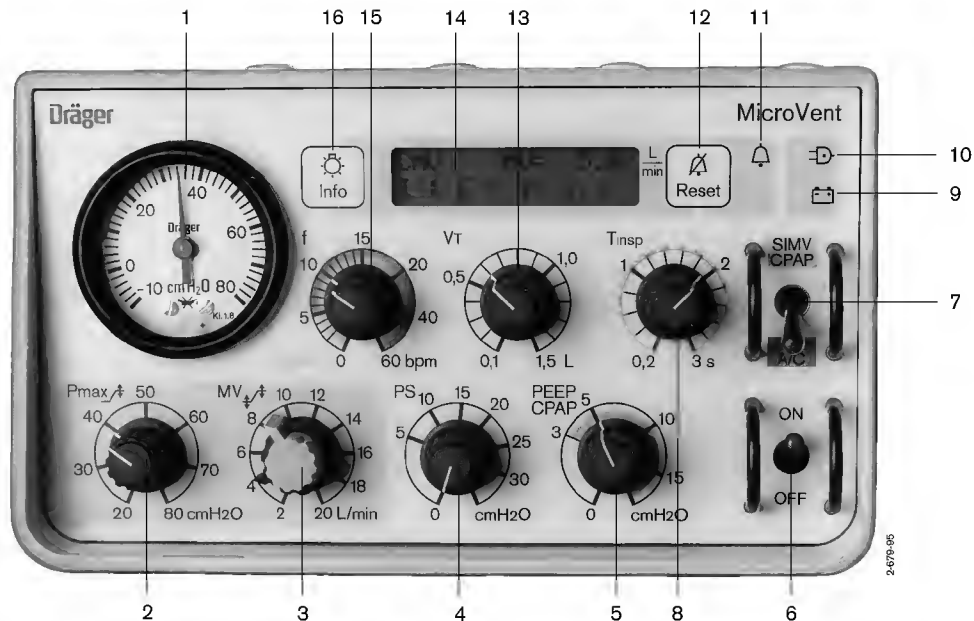
Problem / Message	Likely causes	Remedy
Measured value MV = 0	Measured minute volume is less than 2 L/min.	
MV high Alarm status light flashing, intermittent audible alarm.	Patient hyperventilates.	
	Upper alarm limit too low.	Adjust upper alarm limit.
MV low Alarm status light flashing, intermittent audible alarm.	Flow sensor defective or dirty.	Exchange flow sensor.
	Disconnection/leakage.	Make sure connections are leak free.
	Flow sensor defective or dirty.	Exchange flow sensor.
MV low Alarm status light flashing, intermittent audible alarm.	Insufficient spontaneous breathing of patient during CPAP.	Switch to SIMV or CMV.
NiCd discharged Alarm status light flashing, intermittent audible alarm. Ventilation stops.	NiCd pack discharged, no external power supply.	Replace NiCd pack with new battery pack, or connect to external power supply.
No NiCd charge This message appears only in Stand-by	No NiCd or battery pack installed, or ambient temperature during charging of NiCd battery pack was outside 32 °F to 95 °F range.	Charge NiCd pack at ambient temperature between 32 °F and 95 °F.
No NiCd/bat.	Machine is connected to external voltage supply, no internal power supply available.	Install fully-charged NiCd pack or new alkaline battery pack.
Paw high Alarm status light flashing, intermittent audible alarm. Full minute volume cannot be applied.	Stenosis in airways. Patient circuit kinked. Lung compliance reduced. Inspiratory flow resulting from settings of V_T , f and $T_{insp.}$ too high.	Clear patient airways. Unkink patient circuit. Set P_{max} higher. Using $T_{insp.}$ knob, set longer inspiratory time = reduce flow.
	Patient "fights" the ventilator.	Change ventilation pattern or mode of ventilation. Sedate patient, if necessary.
Paw low Alarm status light flashing, intermittent audible alarm.	Disconnection/leakage at patient connection, ventilation valve or ventilator circuit.	Make sure connections are leak free.

Troubleshooting

Problem / Message	Likely causes	Remedy
PEEP-high Alarm status light flashing, intermittent audible alarm.	Ventilation hose kinked .	Unkink ventilation hoses.
Press.Supp.> 4 s	Leak in patient connection or in hose system.	Make sure connections are tight
	Diaphragm in ventilation valve installed incorrectly or damaged.	Install diaphragm correctly or replace.
	Leaking cuff.	Inflate cuff and test for leaks.
Supply press.low Alarm status light flashing, intermittent audible alarm. Ventilation stops	O ₂ cylinder empty, cylinder valve closed.	Check gas supply in O ₂ cylinder; connect to full O ₂ cylinder. Open cylinder valve.
	Gas probe to medical gas pipeline system not properly connected.	Check gas pressure in medical gas pipeline system, make sure that the system pressure is greater than 2.7 bar. Insert gas probe into terminal unit fully.
XX XX XX XX XX Ventilator INOP Ventilation stops. Alarm light continuously lit, continuous audible alarm (XX XX XX XX XX = fault code)	Internal ventilator malfunction.	Switch off ventilator and disconnect from external power supply. Switch ventilator on again. If fault recurs, use backup ventilator and call DrägerService.
No message. Continuous sound for at least 7 seconds.	Sudden failure of internal power supply when external power supply not connected.	WARNING: Immediately begin ventilating patient manually. Connect external power supply. Check internal power supply.
No message, no alarm, no machine function	No internal power supply and no external power supply available.	Install charged NiCd pack or new battery pack. Use backup ventilator, if necessary.
Audible alarm of O ₂ -Air mixer (for blender 84 12 411)	Supply pressure of O ₂ or air too low.	Ensure adequate supply pressures.
	Difference in pressure between the two supply pressures is greater than 14 psi.	Equalize supply pressures, so that difference is less than 14 psi.
high rate Alarm status light flashing, intermittent audible alarm.	Breathing rate higher than 30/min for more than 3 minutes	

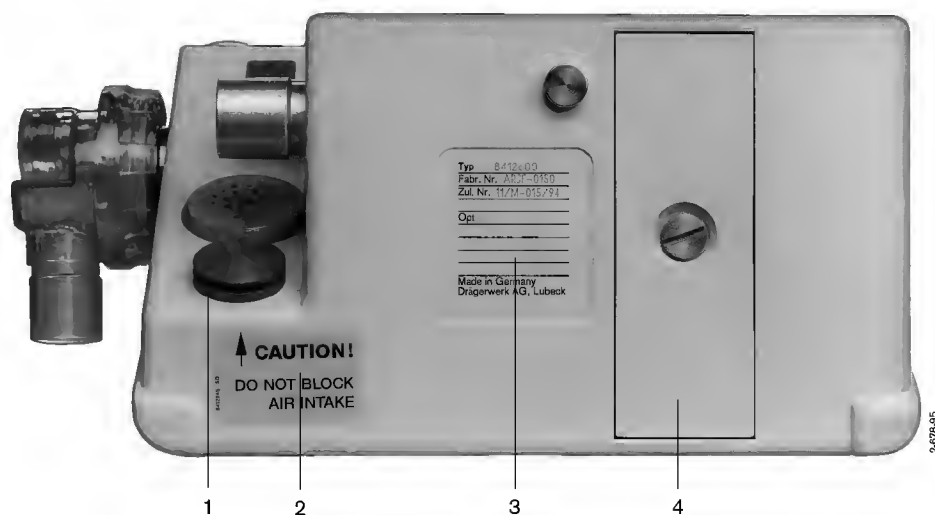
What's What

Front view



- 1 Pressure gauge for airway pressure
- 2 Knob for pressure limitation »P_{max}«; continuously adjustable from 20 to 80 cmH₂O
- 3 Double function knob for upper and lower alarm limits for minute volume
- 4 Knob for Pressure Support »PS«, continuously adjustable from 0 to 35 cmH₂O
- 5 Knob for »PEEP/CPAP«, continuously adjustable from 0 to 18 cmH₂O
- 6 On/off switch »ON/OFF«
- 7 Switch for CMV/AC and SIMV/CPAP ventilation modes
- 8 Knob for setting inspiratory time, T_{insp.}, between 0.2 and 3 seconds
- 9 Yellow status light »Using internal supply«
- 10 Green status light »External DC power supply connected«
- 11 Red alarm status light
- 12 Key for silencing audible alarms for 2 minutes and for resetting screen alarm messages
- 13 Knob for tidal volume, V_T, continuously adjustable from 0.1 L to 1.5 L
- 14 Liquid crystal display for minute volume and other measured parameter values, for alarms and advisory messages.
- 15 Knob for ventilator rate »f«, continuously adjustable from 5 to 60 bpm in CMV and from 2 to 60 bpm in SIMV. Setting of 0 bpm for CPAP.
- 16 Key for switching on display backlighting for 30 seconds and for checking displays and audible alarm. Also for switching between "Info" functions displaying measured values of parameters flow, I:E-ratio, pressure, rate, V_{Texp}.

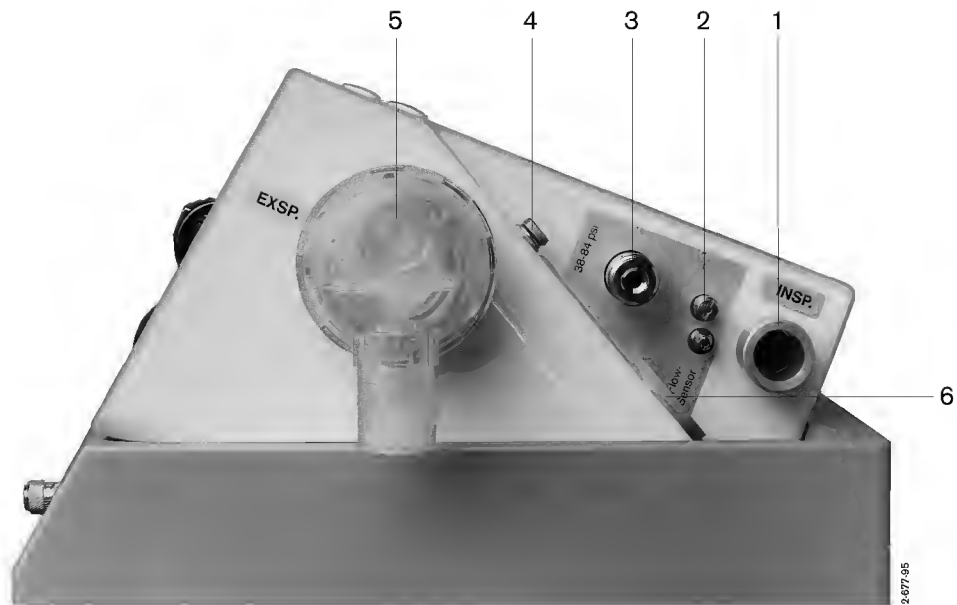
Rear View



- 1 Ventilator air intake and exhaust

WARNING !
Do not block air intake!
Ventilator malfunction will result.

- 2 Air intake label
- 3 Identification plate
- 4 Compartment for internal power source, either rechargeable NiCd battery pack or battery pack with 6 AA batteries.

Side View (Right)

- 1 Inspiratory port, 22mm ISO taper
- 2 Connector nipples of pressure sensing lines (flow measurement)
- 3 DISS connector for high pressure gas supply (O₂, Air or O₂-Air mixture), 40 to 87 psi
- 4 Connector for external DC voltage (AC adapter 84 12 709 or vehicle power supply with converter 84 12 071)
- 5 Expiratory valve
- 6 Beeper

Technical Data

NOTE: Specifications are given conforming to ISO 5369.

Ambient Conditions

For operation

Temperature	
Ventilator	14 to 122 °F (–10 to 50 °C)
AC-adapter	32 to 104 °F (0 to 40 °C)
Atmospheric pressure	600 to 1200 hPa
Rel. humidity	30 to 95 % r.H.

For storage

Temperature	0 to 158 °F (–20 to 70 °C)
AC-adapter	–40 to 158 °F (–70 to 40 °C)
Atmospheric pressure	600 to 1200 hPa
Rel. humidity	10 to 95 % r.H.

Performance Data

Operating parameters

Control principle	volume flow controlled, time-cycled, volume constant, flow interrupter (microprocessor controlled) spontaneous breathing with integrated demand valve (also at elevated PEEP levels)
Ventilation modes	CMV/AC, SIMV/CPAP
Ventilator rate	
CMV	5 to 60 bpm ±1 bpm
SIMV	2 to 60 bpm ±1 bpm continuously adjustable
Tidal volume V _T	0.1 to 1.5 L continuously adjustable ±10 % of set value, 50 mL minimum
Inspiratory time T _{insp.}	0.2 to 3 seconds ±5 % continuously adjustable
inspiratory pressure limitation P _{max} minimum	20 to 80 cmH ₂ O ±10 % ±3 cmH ₂ O continuously adjustable
PEEP	0 to 18 cmH ₂ O
CPAP	3 to 18 cmH ₂ O
Pressure Support	0 to 35 cmH ₂ O

Expiratory minute ventilation MV

min. 2.0 L/min
max. 25.0 L/min
with I:E = 1:1.5 and effective flow range of 10 to 80 L/min

Characteristics for support of spontaneous breathing

Demand valve trigger pressure	approximately –1 cmH ₂ O
Max. demand flow supply at –4 cmH ₂ O	120 L/min
Synchronization sensitivity for A/C	5 L/min
Base flow for spontaneous breathing	approximately 5 L/min
Ventilator compliance (incl. patient circuit)	<3 mL/cmH ₂ O
Inspiratory resistance	<6 cmH ₂ O/L/s
Expiratory resistance	<6 cmH ₂ O/L/s
Dead space including flow sensor	approximately 28 mL

Measuring ranges

Pressure gauge Accuracy	–10 to 80 cmH ₂ O ±2 cmH ₂ O
Flow measurement range	2 to 120 L/min bidirectional
Max. differential pressure allowed for flow measurement	±4 cmH ₂ O
Resistance of flow sensor	3 cmH ₂ O at 100 L/min
Measurement of minute ventilation	
Range	2 to 40 L/min
Accuracy (at 100 % O ₂ 1013 hPa, 68 °F, 50 %r.H.)	
for 2 to 5 L/min	±1 L/min
for 5 to 40 L/min	greater of ±12 % of measured value or ±1 L/min
Patient connector	male ISO taper, 22 mm

Alarms

Supply press. low

Alarm is activated when supply pressure falls below approx. 22 psi (1.5 bar).

Paw high

Adjusted with knob »Pmax«, alarm is activated when set value of Pmax is reached.

Paw low

Alarm is activated when no airway pressure difference of at least 5 cmH₂O has been reached within two ventilator breaths in CMV or SIMV or if pressure falls below 3 cmH₂O in CPAP mode.

PEEP high

Alarm is activated when airway pressure don't falls below 22 cmH₂O during expiration.

Leakage

Alarm is activated when the expiratory minute ventilation is less than 60 % of inspiratory minute ventilation. The »Leakage« alarm is not functional in CPAP mode.

Apnea

Only functional in CPAP mode. Alarm is activated when no breaths have been detected for 15 seconds.

Check settings

Alarm is activated when an inspiratory flow outside the range of 10 to 80 L/min would result from the set combination of V_T, Rate, and T_{insp}. It is not a message about an operator error and does not need to be reset.

Alarms are generated as visual and audible alarms. The audible portion of an alarm is muted after a condition has been corrected. The message displayed must be reset (to acknowledge).

Self test automatically in fixed time intervals during operation and standby.

Audible alarm loudness 75 dB (A) in 1 m distance

high rate Alarm is activated when the breathing rate exceeds 30/min during 3 minutes. This alarm can switched ON/OFF in the Customer Service Mode.

Operating Data

Gas supply

Supply gas O₂, medical air, or mixtures

WARNING !

MicroVent is not intended to be used with gas mixtures of nitrous oxide

O₂ concentration ±3 % of set value when operated with blender
84 12 411

Requirements for the supply gas medical grade from wall pipeline, from cylinders, or from air compressors

WARNING !

Always use medical grade oxygen or air that is dry and free from dust and oil. Contaminated gas may cause ventilator malfunction.

Supply pressure 38 to 84 psi (2.7 to 6.0 bar) at 80 L/min.

Max press. difference between O₂ and Air when operated with blender: 20 psi (1.2 bar)

Gas connections pursuant ISO 5359, Annex A (DISS)



Gas consumption
Ventilator for internal pneumatic control circuits approximately 1.0 L/min about 2.5 L/min base flow in any ventilation mode (TI:TE 1:1)

Blender approximately 12 L/min O₂-Air mixture

Nebulizer port approximately 3 L/min at 72 psi (5 bar) supply pressure

Typical times of operation with minute ventilation of 10 L/min
E-cylinder without blender: approximately 46 minutes

Electrical supply

Electrical power input into MicroVent	12 V \pm 1 V DC
Connection to external supplies 12/24/28 V DC	via DC/DC converter (84 13 017)
Fuse	T1L 250V IEC 127-2 (behind lid of battery compartment)
Connection to external AC source	via AC adapter (84 12 709) input: 120V/60Hz AC max. 200 mA output: 12 V DC max. 600 mA
Current consumption during rapid charge ventilator off	300 mA (for 8 hours, after that automatic switch to trickle charge)
ventilator on during trickle charge	390 mA 30 mA
Ambient temperature range during charge of NiCd	32 to 95 °F (0 to 35 °C)
Time of operation with internal NiCd or alkaline battery pack	max. 2 hours at 41 to 122 °F (5 to 50 °C) with typical settings
Insulation class of power supply	II  pursuant IEC 601
Classification	type BF 

Physical Characteristics

Dimensions (W x H x D)	215 x 120 x 205 mm (8,5 x 4,7 x 8,1 inches)
Weight	4.3 kg (9.5 lbs)
Noise level during operation	48 dB(A) in 1 m distance

Construction materials

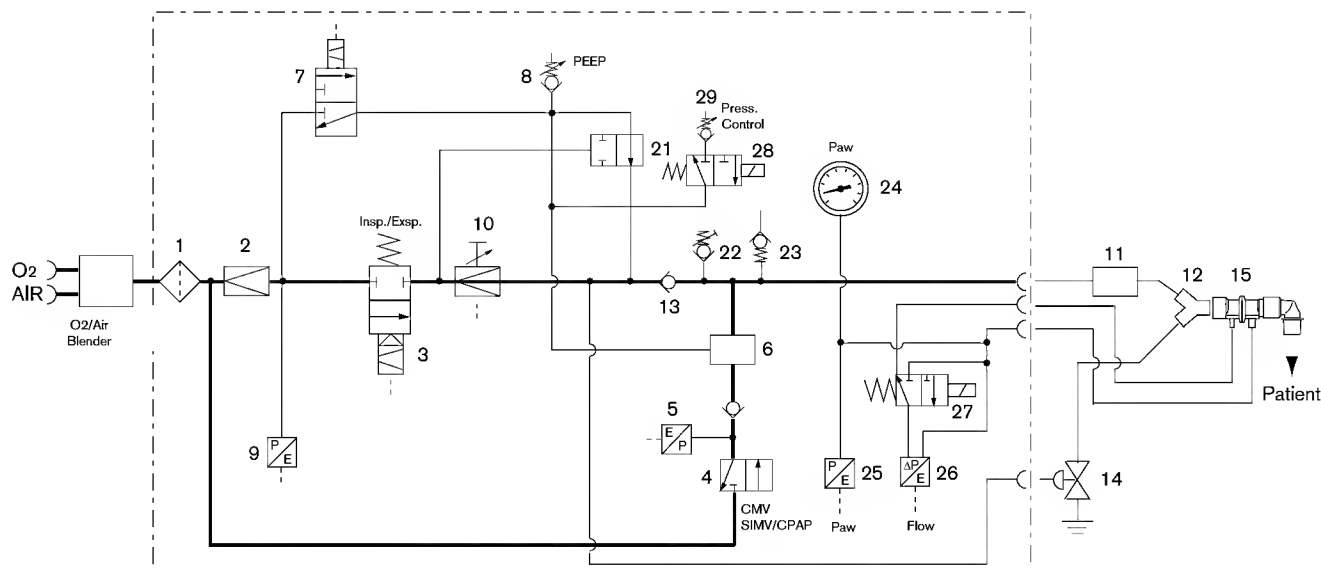
Ventilator enclosure	Impact resistant ABS plastic
Reusable patient circuit	silicone rubber
pressure sensing lines for flow measurement	silicone rubber
flow sensor housing	polysulphone (PSU)
flow sensor membrane	stainless steel
Expiration valve housing	polysulphone (PSU)
Expiration valve membrane	silicone rubber
ventilator front panel	
key pad	polyester membrane

Certificates

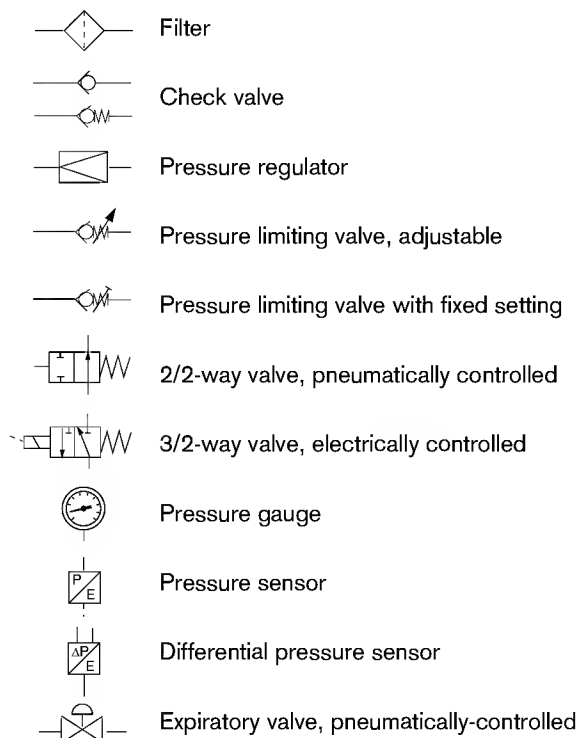
The MicroVent ventilator has been tested for electromagnetic compatibility according to the following standards and guidelines:

Electromagnetic emissions and immunity	IEC 601-1-2 prEN 794-1 MIL-STD-461D/462 RE 101 / RS 101 / CS 101
Vibration and shock test	MIL-STD-810E

Theory of Operation



Symbols for Pneumatic Components



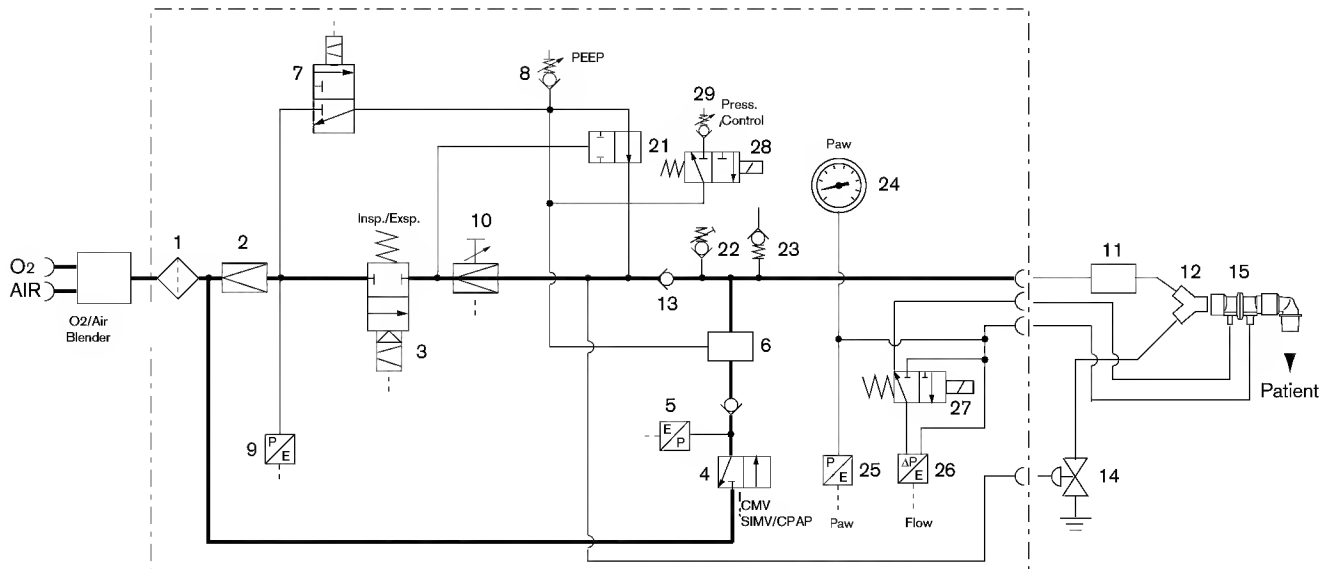
Gas Supply

Supply gas is also routed to 3/2-way solenoid valve »Insp./Exp.« and to demand valve **6** via 3/2-way solenoid valve »CMV/CPAP«. System pressure is supplied to PEEP valve **8** via solenoid valve **7** and is monitored by pressure sensor **9**.

CMV/SIMV

Inspiration

3/2-way solenoid valve »Insp./Exp.« **3** releases gas flow. Gas flow is controlled via electrically operated flow valve **10** and reaches the patient circuit via check valve **13**, humidifier **11**, wye connector **12**, and flow sensor **15**. At the same time, expiratory valve **14** is closed. The controlled 2/2 way valve **21** prevents the inspiratory gas from escaping to the mechanical PEEP valve **8**. The pressure-limiting valve **22** limits the inspiratory pressure to a maximum value, independent of the P_{\max} control unit.



If the gas supply fails, additional ambient air can be drawn via an additional valve **23**. Airway pressure is measured by pressure gauge **24** and pressure sensor **25**.

Expiratory flow generates a proportional differential pressure within flow sensor **15**. It is measured with differential pressure sensor **26** and used to determine minute volume.

The automatic zero calibration of pressure sensor **26** is carried out with 3/2 way valve **27**. The bi-stable 3/2 way solenoid valve "Insp./Exp." **3** interrupts gas flow either in a time-cycled fashion (at the end of inspiratory time) or pressure controlled (when the set pressure P_{max} is reached).

Expiration/PEEP

The gas in the control line to the expiratory valve is released via 2/2 way valve **21** to the endexpiratory pressure level set with PEEP valve **8**.

The patient can then exhale via flow sensor **15** and expiratory valve **14** to ambient air. The PEEP pressure set with PEEP valve **8** is superimposed on expiratory valve **14**.

CPAP

Monitored by pressure sensor **5**, 3/2 way valve **4** releases gas flow to demand valve **6**.

Inspiration/Expiration

Controlled by the patient's inspiratory effort, demand valve **6** supplies the appropriate volume to the patient. This supply is stopped when the patient decides to start expiration.

The demand valve generates the desired CPAP pressure in the patient circuit, using the PEEP/CPAP set with PEEP valve **8**.

Pressure Support

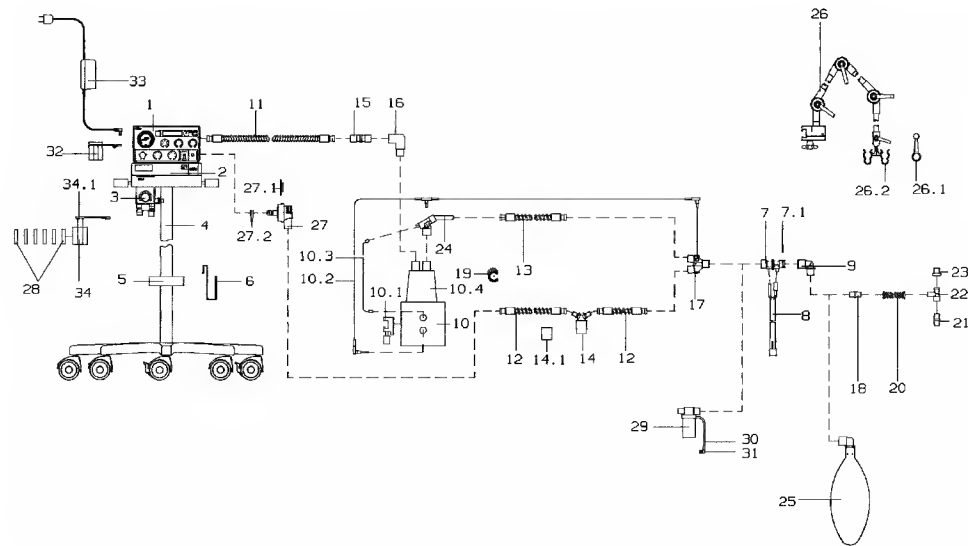
During spontaneous breathing, the patient can trigger pressure support which is controlled by a flow trigger and 3/2-way valve **28**.

Demand valve **6** produces the desired pressure support with the pressure set on PS-valve **29**.

Base flow

A base flow of about 5 L/min is supplied to the breathing system.

Parts List






Item No.	Name	Order No..	Item No.	Name	Order No.
1	MicroVent	84 13 050	19	Hose clip	84 03 566
2	Ventilator mount	84 13 047	20	Corrugated hose	84 02 041
3	Blender	84 13 046	21	Pack of catheter connectors, adult	84 03 685
4	Mobile stand	84 12 585	22	Adapter adult	84 03 076
5	Compact rail	2M 85 337	23	Cap	84 01 644
6	Hose bracket	2M 85 446	24	Hose Heater Assembly	84 11 045
7	Flow sensor	84 12 034	25	Adult test lung	84 03 201
7.1	O-ring	R 26 807	26-26.2	Hinged arm	84 09 609
8	Flow-measuring hose	84 10 929	26.1	Holder	84 09 841
9	90° angled connector	84 12 235	26.2	Hose clip	84 09 746
10	Fisher & Paykel humidifier	MR 730 ¹⁾	27	Expiratory valve	84 12 610
10.1	Mounting kit F & P	900 MR 088 ¹⁾	27.1	Diaphragm	84 10 653
10.2	Dual Airway Temp. Probe	900 MR 568 ¹⁾	27.2	O-ring	84 00 827
10.3	Electrical Adapter	900 MR 558 ¹⁾	28	Battery	13 35 804
10.4	Humidification chamber	MR 730 ¹⁾	29	Medicament nebulizer, pneumatic	84 04 951
11-24	Reusable patient circuit, silicone, adult size	84 12 108	30	Hose, 2m	12 03 622
11	Spiral hose, adult silicone 0.35 m	21 65 619	31	Plug-in nipple	84 04 951
12	Spiral hose, adult silicone 0.60 m	21 65 627	32	NiCd pack	84 11 599
13	Spiral hose, adult silicone 1.10 m	21 65 635	33	AC adaptor (120 V, 60 Hz, USA/Canada)	84 12 709
14	Water trap	84 04 985	34	Battery holder	18 35 505
14.1	Container	84 03 976	34.1	Connecting cable for battery compartment	84 12 072
15	Connector	M 25 647			
16	Elbow connector	M 25 649			
17	Y-piece, (F & P)	900 MR 558 ¹⁾			
18	Catheter connector, straight size 12.5 (pack of 10)	M 23 840			

1) direct order from F & P, New Zealand contract with Drägerwerk AG, Lübeck dated Aug. 92

Glossary

Glossary

A/C	Assist Control Ventilation. synchronized controlled ventilation with intermittent positive pressure	T _{insp}	Inspiratory time
AIR	Air	V _T	Tidal volume
CMV	Controlled Mandatory Ventilation		Alarm silence
CPAP	Continuous Positive Airway Pressure Breathing Spontaneous breathing with continuous positive airway pressure		Alarm
f	ventilator rate		Internal power supply
FLOW	Inspiratory flow		External DC power being supplied (from AC adapter)
DISS	Diameter Indexed Safety System for threaded medical gas supply connectors	*	Synchronized ventilator breath
I : E	Ratio of inspiratory versus expiratory time		Display backlighting
ISO	International Standards Organisation		Observe Operating Instructions
LCD	Liquid Cristal Display		Classification (IEC 601-1) type BF
MEAN	Mean airway pressure		
MV	Minute Volume		
MV _±	lower and upper alarm limit for minute volume		
O ₂	Oxygen		
Paw	Airway pressure		
PEAK	Peak pressure		
PEEP	Positive EndExpiratory Pressure		
P _{max} 	Maximum airway pressure		
PS	Pressure support during spontaneous breathing		
Reset	Alarm reset		
SIMV	Synchronized Intermittent Mandatory Ventilation		
SW-Version	Software version		

Ordering Information

Name and Description	Order No.
Basic ventilator	
MicroVent, USA	84 13 050
consisting of: ventilator unit, expiratory valve, flow sensor, flow sensor lines, 90° elbow connector	
Accessories required for operation	
Ventilator mount (incl. connecting hoses)	84 13 047
Mobile stand	84 12 585
Oxygen blender	84 13 046
High pressure Air hose 3 m (10 ft), DISS	45 00808
High pressure O ₂ hose 3 m (10 ft), DISS	45 00807
AC adapter (120 V, 60 Hz, USA)	84 12 709
NiCd pack	84 11 599
Special accessories	
Hinged arm	84 09 609
Hose bracket	2M 85 446
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100...110 V, 50/60 Hz or 127 V, 60 Hz	84 10 173
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These Instructions for Use apply only to
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with Serial No.:

If no Serial No. has been filled in by
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Distributed by

Dräger Medical, Inc.

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